New Junior Encyclopedia

Vol 4

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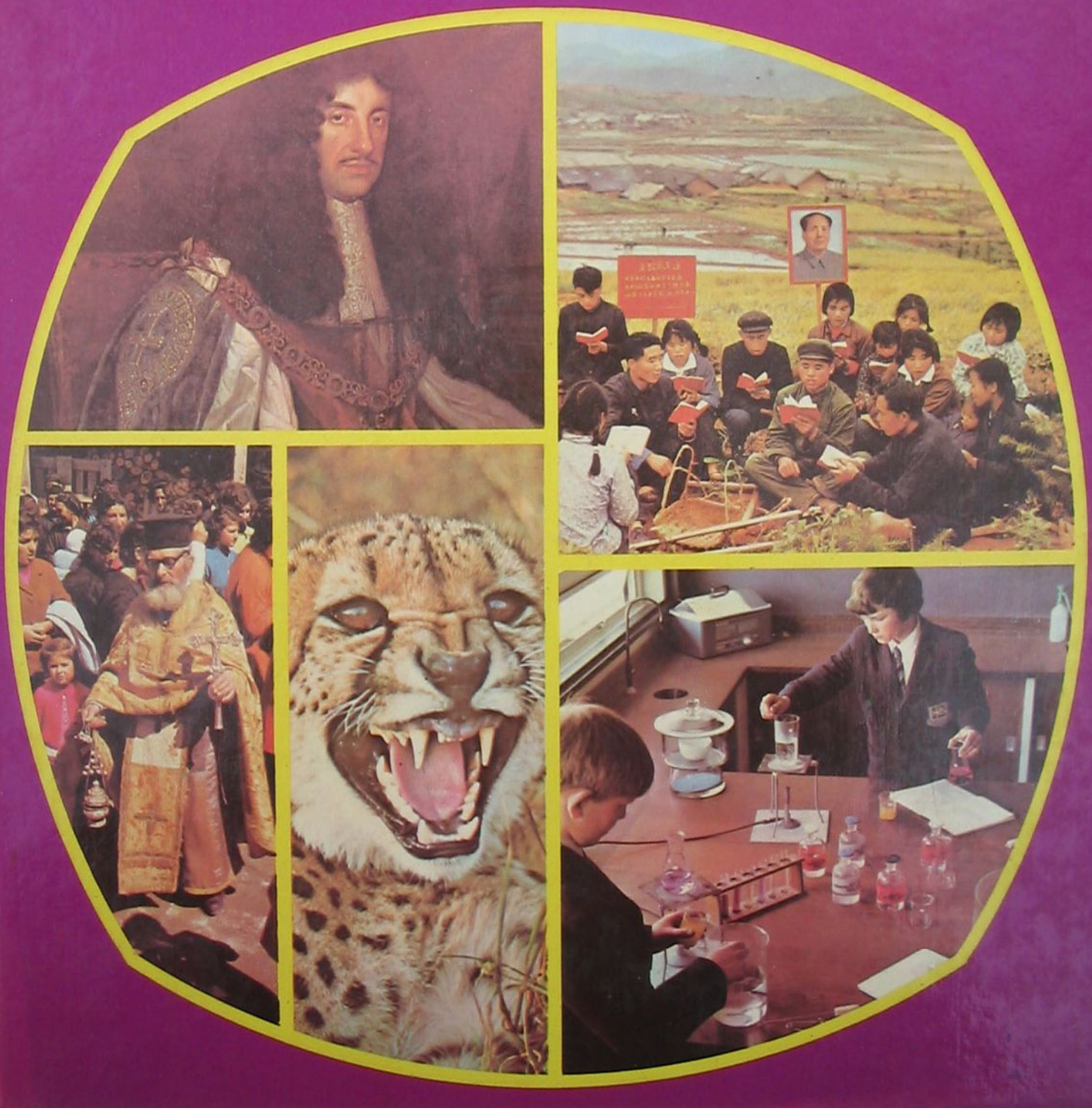

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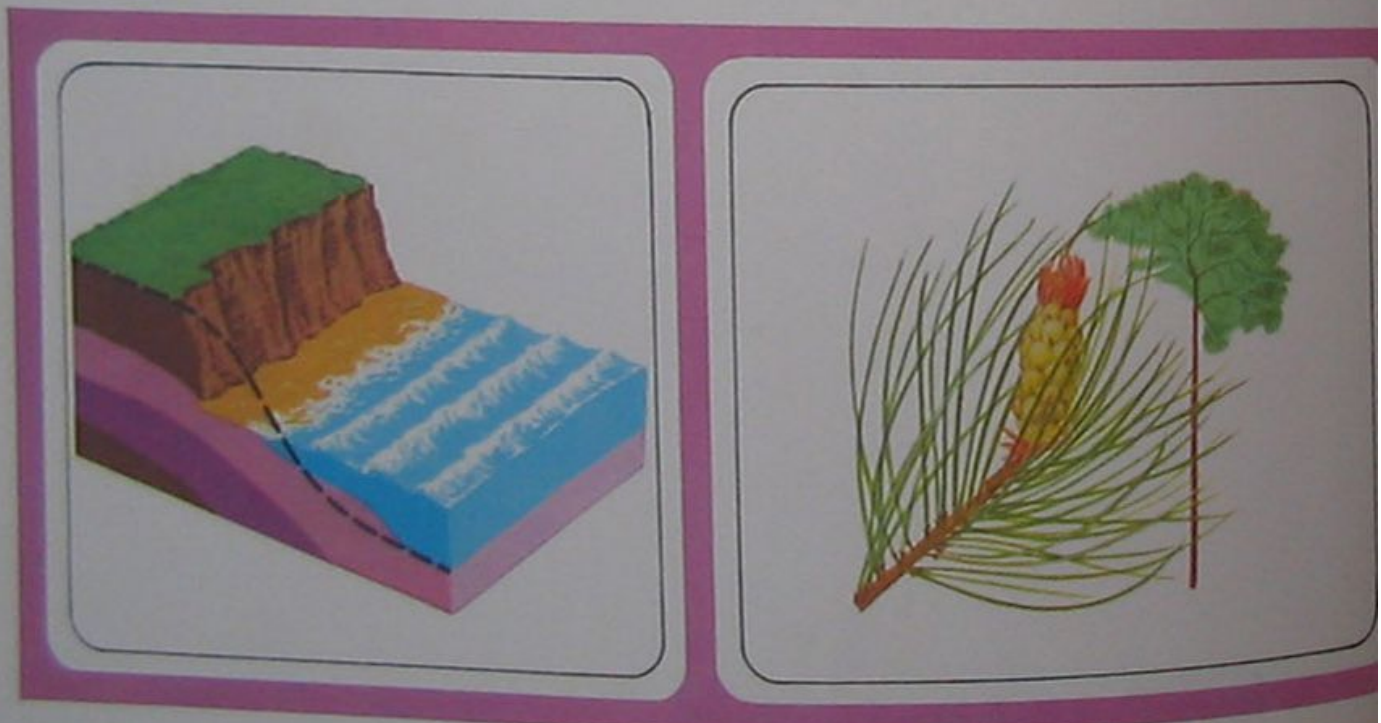

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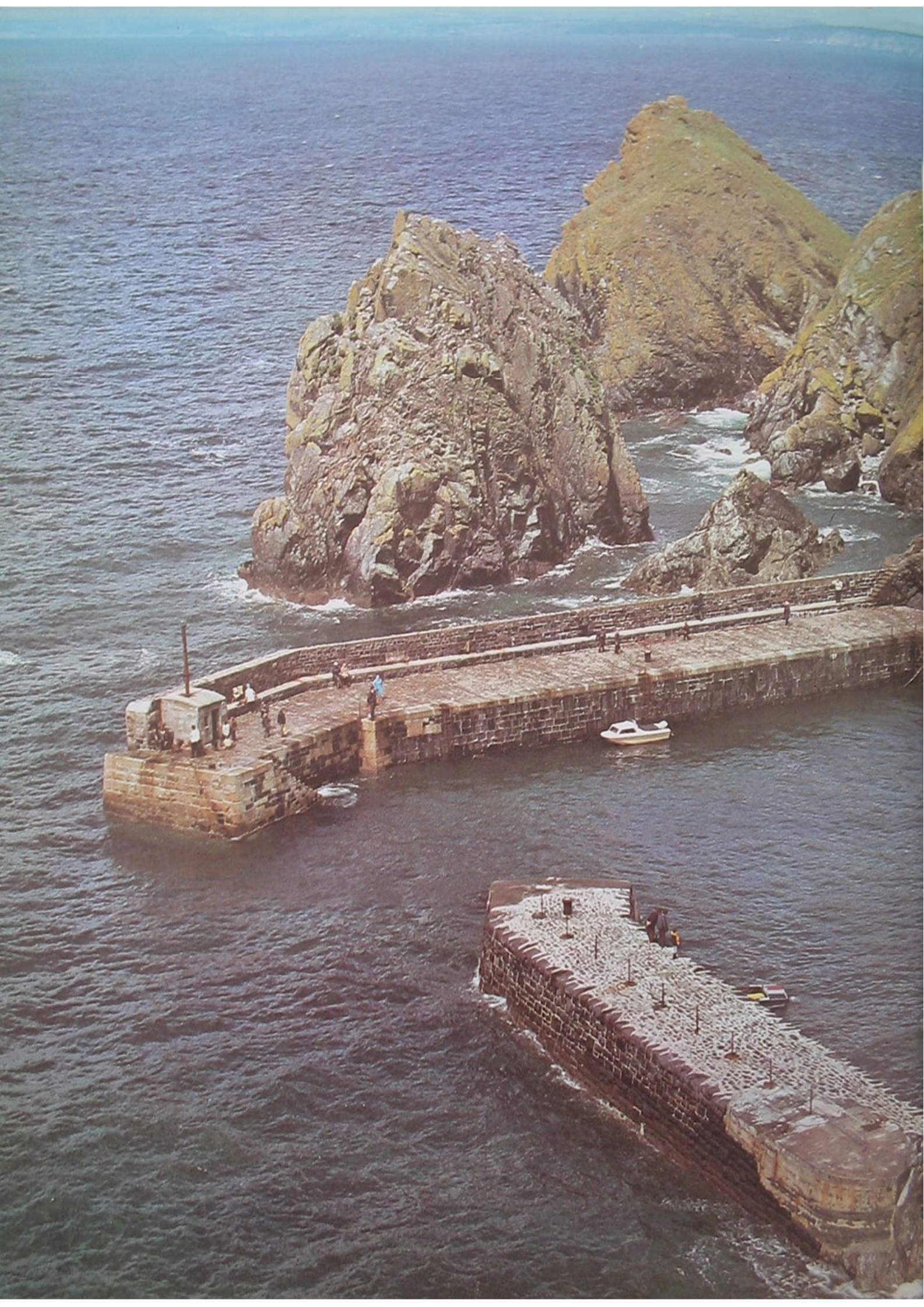


Catherine the Great (1729-1796), a shrewd and talented woman, was empress of Russia for 34 years. She increased Russia's influence in European affairs by adding Poland to its territory and defeating Turkey to win the Crimea and the Black Sea.

Catherine introduced advanced ideas of education, medicine and the arts to her country, and was herself a gifted writer and painter. But she did little to help the majority of the people of Russia, whose lives were poor and miserable. Instead, she extended serfdom, crushed attempts of the peasants to help themselves, and added to the power and privileges of the nobility.

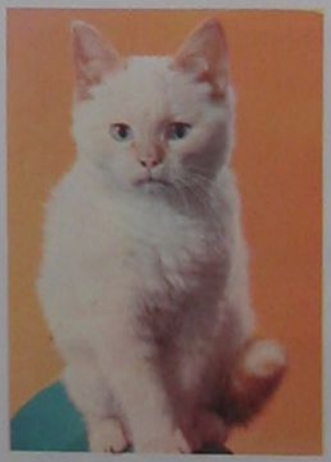
Catherine was born a German princess. At 16 she came to Russia to marry the heir to the throne. He became *tsar* (emperor) in 1762 as Peter III, but ruled only six months before Catherine deposed him.

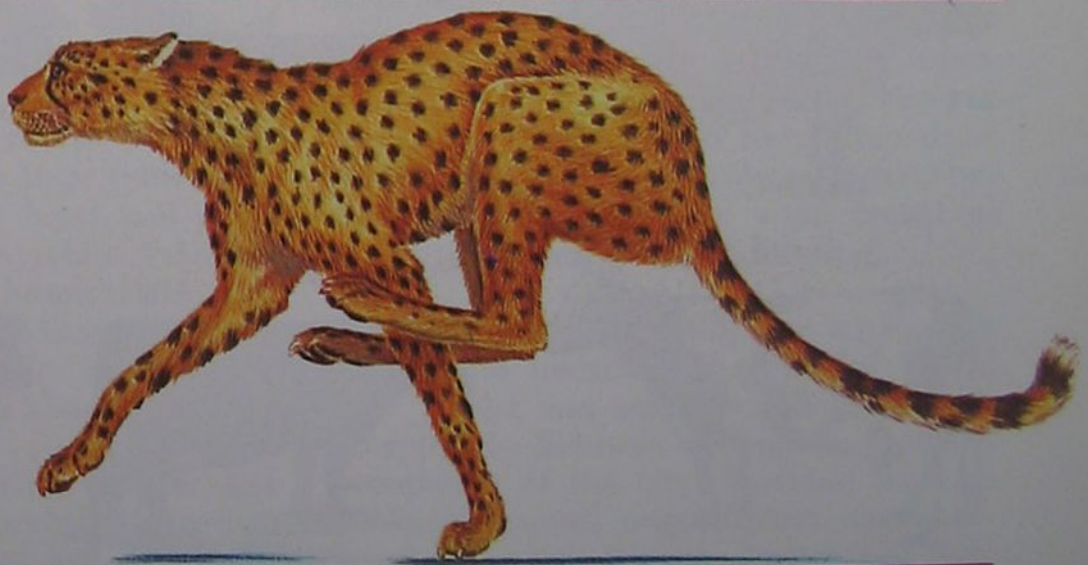
Catherine the Great of Russia was the wife of Tsar Peter the Third. He ruled for only six months before the German-born Catherine deposed him.

Cats are popular pets, but they are closely related to some of the biggest and most fierce of all wild animals. Lions, tigers, and domestic cats are all members of the same family of mammals, and—in spite of their differences of size—they have a lot in common.

All cats, for instance, are flesh-eaters and hunt for their food. The only prey a house cat is likely to take is the occasional mouse or bird, but it goes about catching it in much the same way as a lion or tiger hunts. They creep stealthily on their soft, padded feet, stalking their prey. Then they leap and kill the unsuspecting animal with one blow of a paw, or by digging in their sharp claws or fangs.

All kinds of cats have extremely sharp *canine* (eye) teeth. These are characteristic of flesh-eaters. Almost all cats have claws





Above: A white Siamese kitten. Right: The cheetah's powerful hind legs can push it to 70 mph.

that retract (draw in), when not in use, to protect their points. But, above all, all members of the cat family have features that are recognizably similar, with long sensitive whiskers.

The cat family is divided into two main groups: the *great* and *lesser* cats. The cheetah – the fastest of all four-legged animals, reaching 70 mph – is classified on its own. Lions, tigers and leopards are all great cats (see Leopard; Lion; Tiger). The lesser cats include many species of wild cats, from which domestic breeds were reared.

The first domestic cats were used by the ancient Egyptians to catch rats and mice in grain-stores. Interbreeding between these animals and European wild cats gave various breeds of domestic cats. The two main kinds of domestic breeds are the *long-haired* and the *short-haired*. Both types include white, black, blue, cream, tabby (striped), and tortoise-shell (patchwork) cats. Tabbies may be grey or reddish in colour. Siamese cats have cream-coloured fur, with darker ears, face, feet and tail. Persian and Angora cats have thick, silky fur. The Manx cat has no tail. It is a short-haired breed.

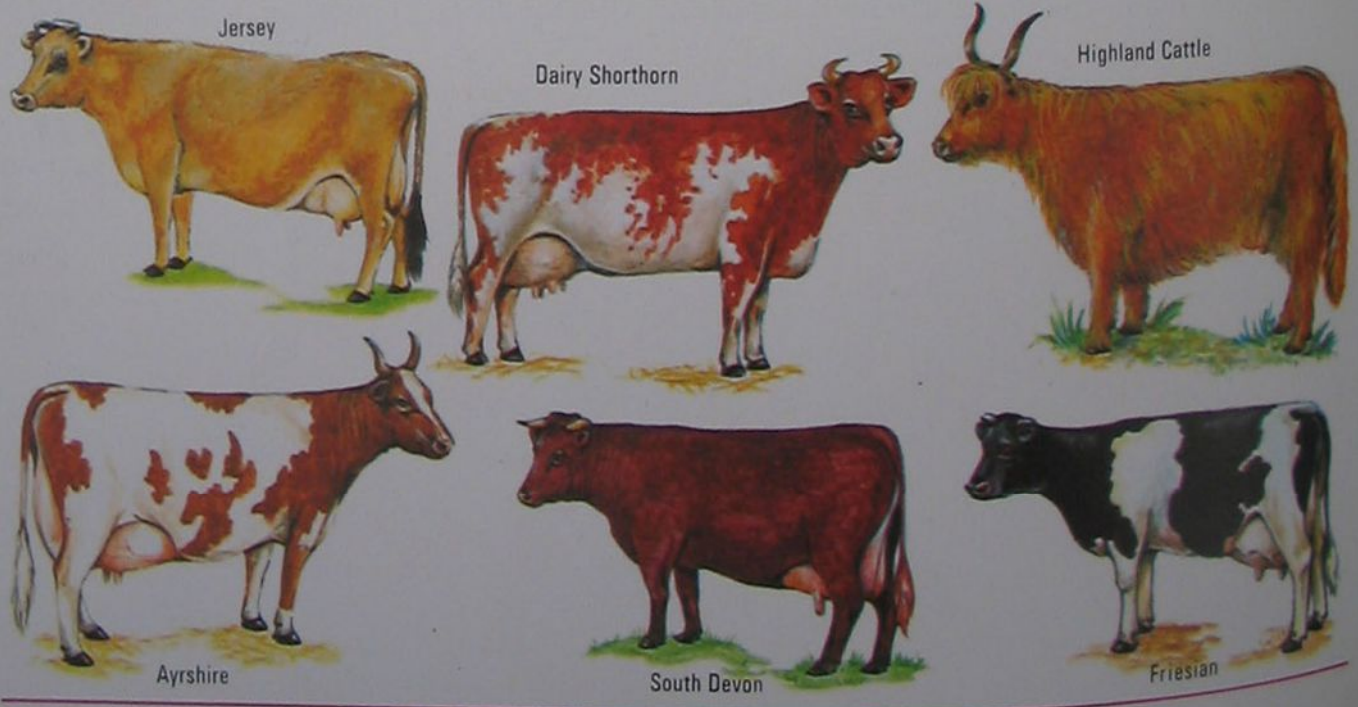
The Aberdeen-Angus is a breed of beef cattle. It has the heavy build and deep chest characteristic of beef cattle.

The Guernsey is a breed of dairy cattle. Its light build, large udder and long neck are features of dairy cattle.

Cattle are important farm animals from which we get beef and veal, milk and butter, cream and cheese. Leather comes from the hides of cattle, and glue can be made from their bones.

There are two main kinds of cattle. *Beef* cattle are kept for their meat, and *dairy* cattle for their milk. India has the most cattle in the world, but as Hindu religious principles forbid the slaughter of cattle, these cattle are kept as dairy cattle. Other countries with many cattle include the United States, Brazil, Argentina, Russia, Australia and New Zealand.

Cattle belong to the ox family of animals, together with buffalo and bison. They are large, unintelligent creatures. All cattle had horns originally, but many horn-less *(polled)* breeds now exist. Farmers sometimes remove the horns with special



Prehistoric cave-painting from Lascaux, France. Many of them show hunting scene which experts think were meant as magic to ensure success in hunting.

tools to prevent the animals hurting each other. Their stomachs have four parts; food can be stored in one part and returned to the mouth to be chewed as a *cud*. Milk is produced from the udder by squeezing the teats; this can be done by hand or by suction in a milking machine.

Beef cattle are large, stocky creatures with small udders used only for feeding the calves. They have short heads and thick necks and short legs. Breeds of beef cattle include the Aberdeen-Angus and Hereford. Dairy cattle tend to be smaller than beef cattle. They are easily recognized by the large udder, but they also have a longer head and neck. Dairy cattle include the Ayrshire, Friesian, Guernsey and Jersey. Some cattle are bred both for their milk and for their meat. These dual-purpose cattle include the Danish Red, Red Poll and Shorthorn.

Cave paintings of amazing realism and grace were made by prehistoric artists more than 14,000 years ago. Beautiful pictures of animals in motion—horses, oxen, reindeer and bison—have been found on the ceilings and walls of caverns at Altamira, in Spain; at Lascaux, in France; and in southern Italy.

Cavemen used such natural substances as charcoal, clay and iron ore to make red, brown, yellow, black and white pigments. They put the paint on with crude crayons, twig brushes or blowing tubes. Sometimes they carved their designs right into the rock, and they often drew one picture on top of another. Experts believe that the drawings were meant as magic to ensure success in hunting.

Cavell, Edith (1865-1915), was an English nurse who became a heroine of World War I. She was matron of a Red Cross Hospital in Brussels during the German occupation of the city. Working through an underground organization, she sheltered about 200 French, British and Bel-

Edith Cavell, the English nurse, who was shot by the Germans during the First World War for helping Allied soldiers to escape.

gian soldiers in the hospital and helped them escape to the Netherlands.

The Germans arrested Edith Cavell, and she admitted helping soldiers to escape. She was shot by a firing squad, despite the efforts of various governments on her behalf. Before she died she said, 'I realize that patriotism is not enough. I must have no hatred or bitterness towards anyone'.

Caves can be found along most sea coasts. The constant pounding of the waves against the cliffs gradually wears away holes in the base.

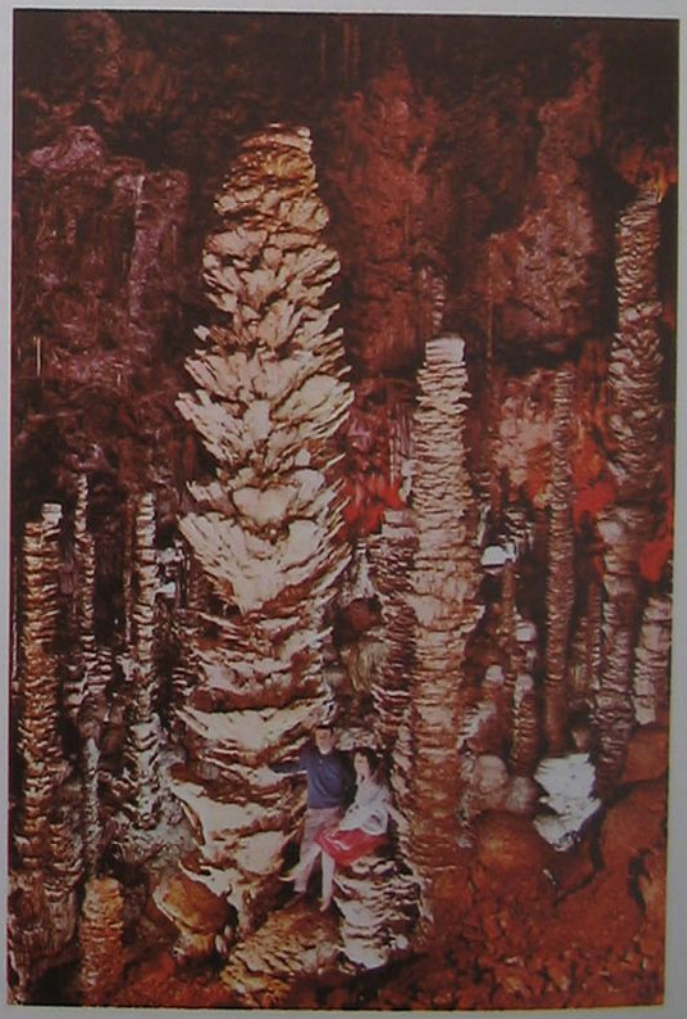
However, the largest and most extensive cave systems are to be found inland. Caves are a notable feature of limestone hills and mountains. Rainwater containing dissolved carbon dioxide is a very weak acid, and it can gradually dissolve limestone. The water trickles through and enlarges cracks in the rock and disappears underground. There it dissolves and wears away channels which over the years become enlarged into caves.

The colouring used in the prehistoric cave-paintings in south-western France and northern Spain was based on ochre for the red, yellows and browns, and oxide of manganese for blacks and dark browns. Lumps of pigment were used as crayons but more usually these pigments were ground to a powder and mixed with a fatty or watery medium to make paint.

The most striking features of these caves are the giant stone 'icicles', or *stalactites*, hanging from the roof, and the stone pillars, or *stalagmites*, rising from the floor. These are caused by the evaporation of drops of water containing dissolved limestone. Each time a drop evaporates on the roof or the floor, a minute speck of limestone is deposited.

These caves are not the 'dead' places they appear to be. In many of them, high in the roof, live vast colonies of bats. In the underground lakes and streams live fish and shrimps; and elsewhere beetles, centipedes, and lizard-like salamanders. Most of these creatures are

Strange limestone columns in L'Aven Armand, France.



blind. The Waitomo Caves in New Zealand are famous for their unique colony of glow worms.

Cell All living things, both plants and animals, are made up of tiny units called *cells*. Some cells are big enough to be seen without a microscope, but most are so small that thousands must be placed side by side to stretch an inch.

Apart from the very simplest living organisms, *Protozoa*, which consist of a single cell, an animal's body contains many different kinds of cells. They each have a special part to play, but they work together in groups called *tissues*. Important kinds of animal tissue include *muscle tissue*, *epithelium* (tissue that covers, like skin, or forms a lining), *connective tissue* (tissue that supports, holds the organs together and packs the spaces between them) and *nerve tissue*.

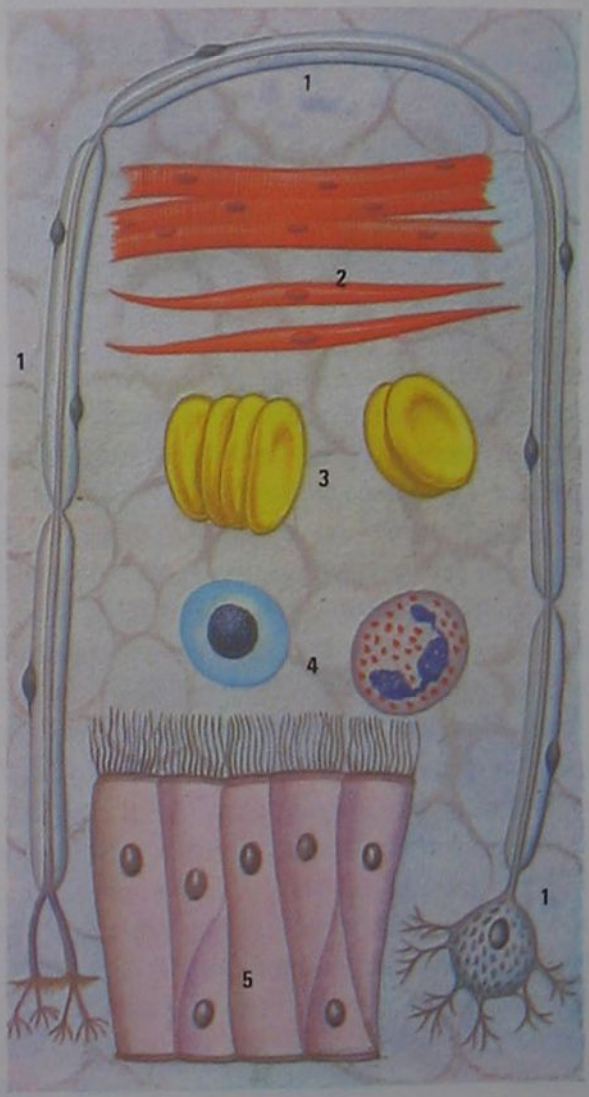
Although cells are the basic units of life, they are themselves extremely complex. Inside them, a tiny replica of the body's processes takes place. A thin sheet, or *membrane*, keeps the shape of the cell. It allows food and oxygen to pass into the cell and waste products to pass out. In plants, a hard *cell wall* surrounds the membrane, but, unlike the membrane, is not a living part of the cell.

The cell itself is made up of *protoplasm*, an extremely complicated mixture of substances. It is like a blob of jelly, but contains many minute structures, each with special jobs. A dense central spot called the *nucleus* is the most important of them. All but a very few kinds of cell, such as red blood cells, have a nucleus. It acts as the 'brain' of the cell and controls all its activities, such as growth and reproduction. Without a nucleus, the rest of the cell soon dies.

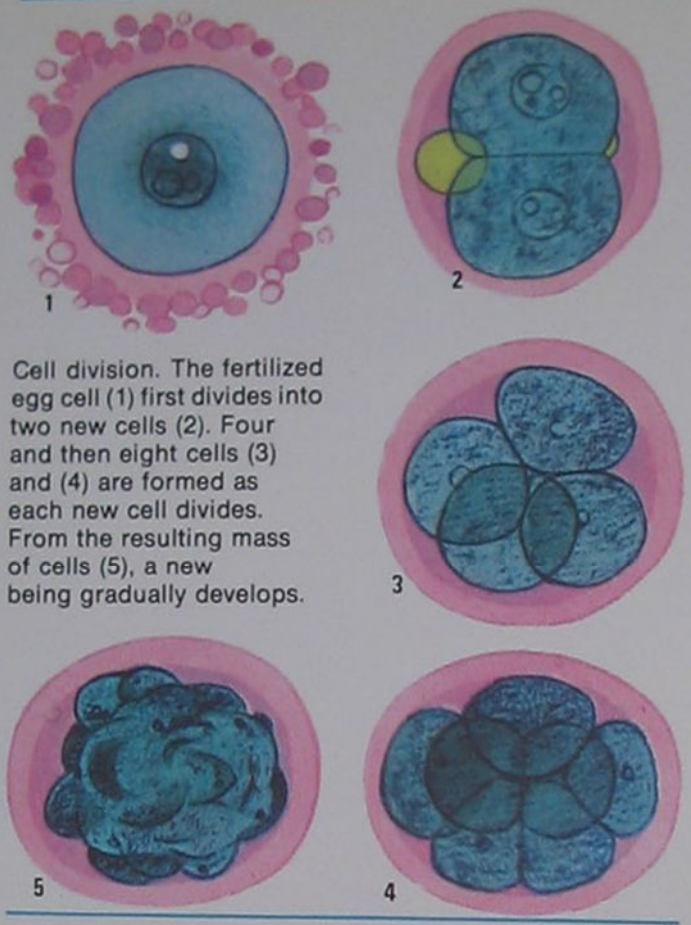
Every living thing starts life as a single cell. The cell must *reproduce* itself many times to form the body of the plant or animal. It does this by dividing into two by a process called *mitosis*.

The first part of the cell to divide is

Above: A cross-section of a cell showing the nucleus in the centre. Left: Some typical animal cells. (1) A single nerve fibre (2) Muscle fibres (3) Red blood corpuscles (4) White blood corpuscles (5) Epithelial cells.



the nucleus. This contains tiny thread-like *chromosomes*, which control the nature both of the cell and of the body. They carry the *genes* that pass on people's characteristics, such as the colour of their eyes. Each kind of creature has a certain number of chromosomes to each cell. Man, for example, has 46.



Cell division. The fertilized egg cell (1) first divides into two new cells (2). Four and then eight cells (3) and (4) are formed as each new cell divides. From the resulting mass of cells (5), a new being gradually develops.

In the first stage of mitosis, these chromosomes divide lengthwise into two identical chromosomes. The pairs separate, and move to opposite ends of the cell. The rest of the cell then divides to give two new cells, identical to the old one. At least, the two so-called *daughter* cells *seem* to be identical. But as the division process goes farther, first to make 4 cells, then 8, then 16, 32, 64, and so on, the cells gradually begin to get specialized. Some develop into bone cells, others into nerve cells, and so on. The single fertilized egg cell develops into a complete creature, with all its distinct organs, which are made up of tissues that are made up of special kinds of cells. How this process comes about is still a great mystery.

Cellini, Benvenuto (1500-1571), was a renowned Italian goldsmith and sculptor who lived during the Renaissance. His work was decorative and skilful, and was sought by princes, kings and popes. One of his most famous pieces of work was a gold and enamel salt-cellar with figures of Earth and Neptune.

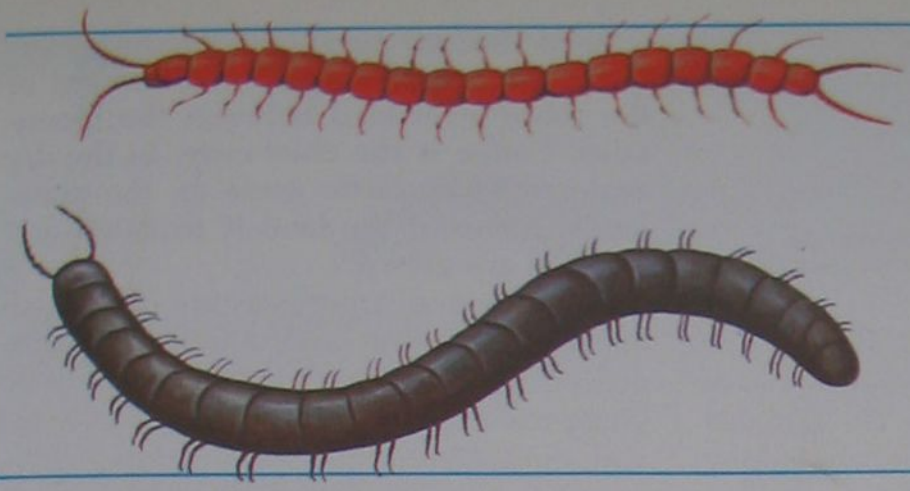
But Cellini is chiefly remembered for his autobiography, which gives a unique picture of Renaissance life.

Cellulose is a stiff substance found in the cell walls of most plants. It gives plants their rigidity. Cotton, flax, straw, and wood are particularly rich in cellulose.

Although there is cellulose in such foods as fruits and vegetables, human beings cannot digest much of it. Cows, sheep, and other grazing animals can digest large amounts because they have the necessary enzyme-producing bacteria in their stomachs.

Cellulose has many industrial uses. It goes into paper, explosives, celluloid film, rayon, plastics, and varnish. Cotton fibres or wood chips are the raw material from which industrial cellulose is obtained.

Cellulose comes from a wide variety of plants and trees and is one of the most useful substances that Man gains from the Plant Kingdom. Cellulose is the main ingredient in the fibrous matter in plants and has many uses as can be seen above.



Top: Centipedes have one pair of legs attached to each body segment. Tropical centipedes may be dangerous to man. Bottom: Millipedes have two pairs of legs attached to each segment. They are harmless, but often do damage in the garden.

Celts live on the north-western edge of Europe, the 'Celtic fringe', as the English put it. But the original Celts came from Austria and Switzerland. About 500 B.C. these tall, fair and red-headed people began to use iron. They were the first northern Europeans to do so. With new weapons they conquered Gaul (France), and invaded Italy. They nearly captured Rome in 390 B.C. Between about 250 and 80 B.C. they invaded Britain in waves.

The Celtic languages which survive today—Gaelic in Scotland and Ireland, Cymric in Wales, Breton in Brittany, and the dead Cornish—were adopted by peoples living there before the Celtic invasions. They were short and dark-haired and came from the Mediterranean. Later, Vikings settled in the Highlands and Islands of Scotland and in parts of Ireland.

The original Celts were conquered by the Roman Empire and later absorbed by peoples speaking Germanic languages.

The Waterloo Helmet is a Celtic helmet dating from the first century B.C. It was found in the River Thames.

Centipedes and millipedes belong to the group of animals called *arthropods* (see Arthropods). Other arthropods include insects, spiders and crabs. Centipedes and millipedes both have long bodies consisting of many segments. In centipedes, a pair of legs is attached to each segment, except for a few at each end. 'Centipede' means 'hundred feet', but the actual number varies, depending on the age of the centipede. Adult centipedes have from 15 to 170 pairs of legs, while a young centipede may have as few as seven pairs. Centipedes have feelers on their heads. They also have jaws. The first pair of legs have poison claws, and are used for killing their food. Centipedes eat small animals such as insects, snails and worms. Large tropical centipedes may be dangerous to man.

Millipedes are more like worms in appearance. They have more legs then centipedes, as each segment bears two pairs of legs, but not the thousand that the name suggests. Some millipedes have as many as 230 pairs of legs. Millipedes live on plants and are not harmful to man.

Central African Republic. This country lies in central Africa, entirely surrounded by land. It has an area of 236,293 square miles, most of which lies 2,000 feet above sea level. The capital and largest city is Bangui. Most of its 1,500,000 people are farmers. Peanuts and millet are the chief crops, and large herds of cattle and sheep are reared. The chief exports include

Location map of the Central African Republic.

cotton, coffee and diamonds. The Central African Republic was a French colony called Ubangi-Shari from 1894 until it gained full independence in 1960. It has kept a close relationship with France.

Central America is the narrow strip of land in the tropics that lies between North and South America. It extends from the southern border of Mexico to the northern border of Colombia. Seven countries lie in this region—British Honduras, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. The Pacific Ocean lies to the west and the Gulf of Mexico and the Caribbean Sea, parts of the Atlantic Ocean, lie to the east. The Panama Canal cuts through Panama to link the Caribbean Sea with the Pacific Ocean. A 10-mile strip of land through which the canal runs is called the Canal Zone. Except for the cities of Panama and Colon, the Canal Zone is governed by the United States.

Forests cover much of the eastern coastal plain of Central America. High mountains, including some volcanoes, rise in the central region. A narrow plain borders the Pacific coast. Lake Nicaragua is Central America's largest lake. Another lake, Lake Gatun, forms part of the Panama Canal. Fast-flowing rivers drive the turbines of hydro-electric power stations.

Birds and animals, such as parrots and monkeys, live in the forests of the eastern plains. Here the damp, tropical climate is suitable for mahogany, rubber and balsa trees. Farmers grow bananas and cacao trees on plantations.

Most Central Americans live in the interior, farming the fertile volcanic soil of the more level land between the mountains. Coffee is the chief crop. In the dry eastern plains, cattle graze on the grasslands. Some of the land is irrigated and bananas are grown.

Most Central Americans are of Spanish or mixed Spanish and American Indian descent. Some American Indians live in Guatemala, and Negroes live in Panama and along the eastern coast. Most people are Christians. Some people follow American Indian and African tribal religions. Outside the cities, most people live in villages of wood and clay huts.

Nearly two-thirds of the people work on farms and plantations growing bananas, cocoa beans, coffee and rubber. They also grow many food crops, such as rice, wheat and manioc (for making tapioca). Farmers on the western plains rear large herds of cattle.

Central America is not rich in minerals. Forestry is difficult because valuable timber trees, such as mahogany, are too widely scattered. The only well-developed industries are those producing textiles and tobacco, mainly for sale at home and not for export.

The first known civilization in Central America was that of the Mayan Indians. Later came a civilization of the combined Mayan and Toltec Indians. Aztec Indians founded an empire in Central America in the 1300's. This empire was destroyed by the Spaniards, who conquered the land in the 1500's. Spanish rule continued until the early 1800's, when the people of Central America rebelled. By 1838, they

COUNTRIES OF CENTRAL AMERICA

Country	Area (sq. mi.)	Population	Capital
British Honduras	8,867	122,000	Belize
Costa Rica	19,575	1,800,000	San José
El Salvador	8,260	3,400,000	San Salvador
Guatemala	42,042	5,400,000	Guatemala
Honduras	43,277	2,495,000	Tegucigalpa
Nicaragua	53,938	1,800,000	Managua
Panama	29,209*	1,500,000	Panamá

*Not including Canal Zone (area 553 sq. mi.: population 49,000).

Location Map of Central America

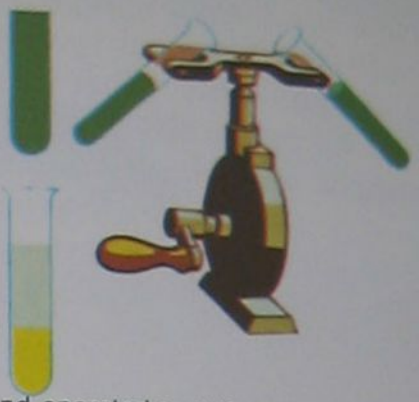
In remote regions of Central America, there are few roads and the rivers have to be used for transport. Left: Some women in Guatemala carry bundles on their heads from their boats.

Below: A colourful market scene in Central America.

had formed five separate republics. Part of Honduras, then under British control, became a British colony. Panama, then part of Colombia, broke away in 1903 and gave the United States permission to start building the Panama Canal.

In 1921, several Central American countries tried to unite under a single government. But they soon quarrelled and split up again. In 1964, the United States and other countries began to explore possible routes for a new canal to replace the Panama Canal.

Centrifugal force. If you tie a weight to the end of a piece of string and whirl it around, the weight will move outwards and feel as if it is going to fly off. This outward tendency is called *centrifugal force*. What is really happening is that the weight is trying to move off along a straight path, but the string is holding it in by an opposite inward force called *centripetal force*.



A small hand-operated centrifuge is used in laboratories to separate the different substances in a mixture. Test tubes are clamped at an angle on an arm which is then rapidly rotated. Centrifugal force makes the contents move towards the outside of the circle described by the spinning tube. The heavier the substance, the greater the force. So the heaviest substances collect at the bottom of the tube and the others, in order of weight, separate above it.

The principle of centrifugal and centripetal force explains the working of the centrifuge, a machine that separates mixed liquids, or solids mixed with liquids, by spinning them around rapidly. The heavier liquid, or solid particles, react more strongly to centrifugal force and are thrown to the outside of the spinning container, while the lighter ones collect in the centre. When the centrifuge stops, the two remain separated; the heavier material lies at the bottom of the container with the light particles above.

In laboratories and in industry, centrifuges have many uses. Dairymen use a centrifuge to separate cream from milk. The heavier milk spins outwards, leaving the lighter cream in the centre. A common example of a centrifuge is the 'spin dryer' for drying clothes. Centrifugal force throws all the clothes against the walls of a perforated drum, and the drops of water are able to travel on through the holes and then drain away.

Below: A Lebanese potter fashions pottery by hand. Bottom: In a modern china factory, a worker takes slices of clay and feeds them into a plate-making machine.

Ceramics is the art of pottery. The term is also used for articles of pottery, whether they are objects of beauty or made to

serve a useful purpose. They are made by heating and shaping clay. China, bathroom tiles, and sewage pipes are among the commonest ceramic products. The clay that is used in all ceramics is shaped when it is wet and soft. It is then *fired* (baked hard) in a *kiln* (a kind of oven) at a very high temperature.

The word *china* was taken from the name of the country of China, because the Chinese were the first to make fine china, several thousand years ago. The finest china is called *porcelain*. Rougher china is called *earthenware*.

China is made by a craftsman called a *potter*. To make earthenware the potter mixes clay and water into a kind of dough. For making round shapes, such as a vase or plate, he throws a lump onto a round disc, known as a potter's wheel, which he keeps spinning while he moulds the clay.

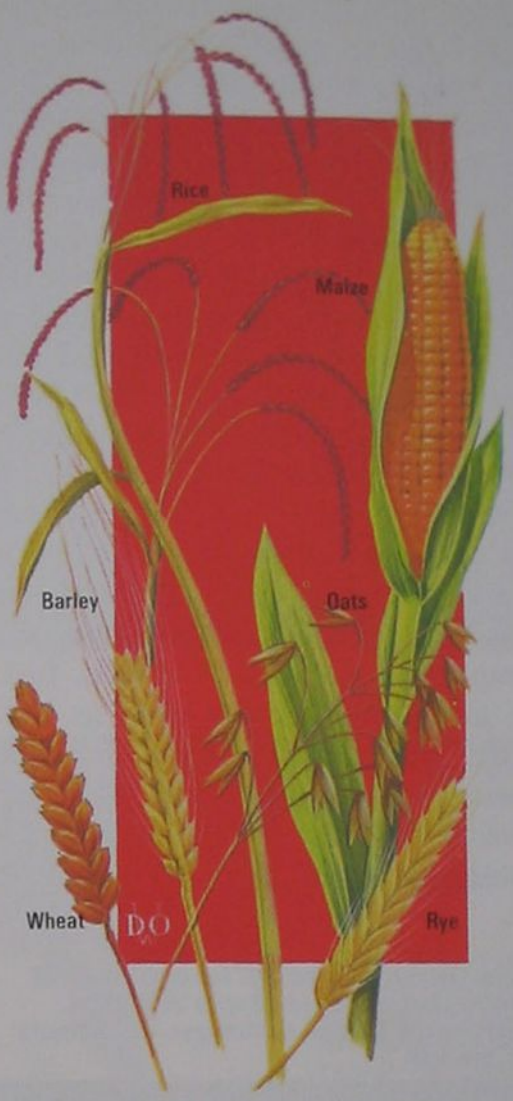
Porcelain was originally made from *kaolin*, a white China clay, mixed with *petuntse*, a China stone that melts in great heat. Other kinds of porcelain are made, such as bone china, but they are not so good. Porcelain is shaped like earthenware and then fired.

Most china has a hard glassy surface, called the *glaze*, which is painted on in a liquid form and then fired to harden it. Much china is decorated by marking or painting the surface before glazing.

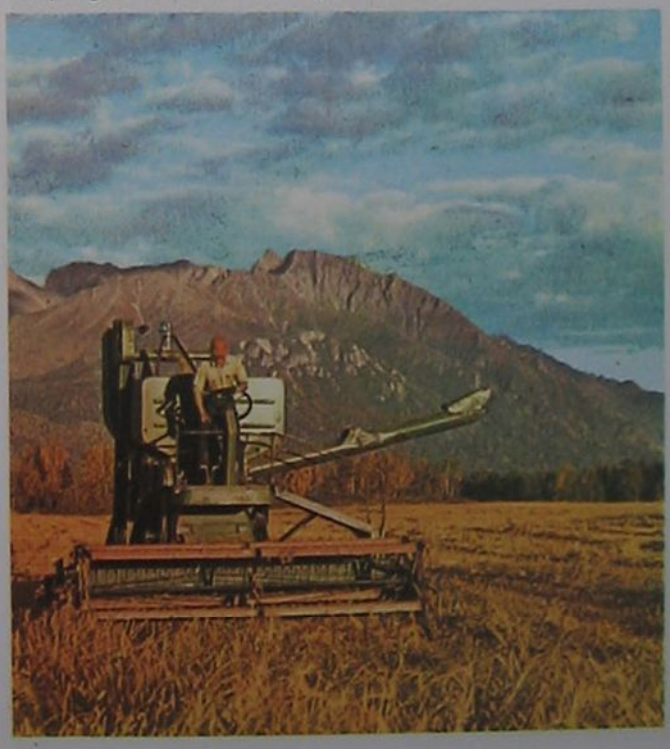
Cereal crops are plants of the grass family that produce seeds useful to man. These crops are barley, maize, millet, oats, rice, rye, sorghum and wheat. The grain is eaten as a food throughout the world, and the most widely used grain food is rice. Some grains are ground into flour. Bread is made from wheat and rye flour. Breakfast foods, cakes and pastries, and animal foods are also made from cereals.

The most important cereal crops are rice, wheat and maize. *Rice* grows in wet, hot regions, and is the staple food of most of the people of Asia (see Rice). *Wheat* is a very important food, especially in

The Main Cereal Crops.



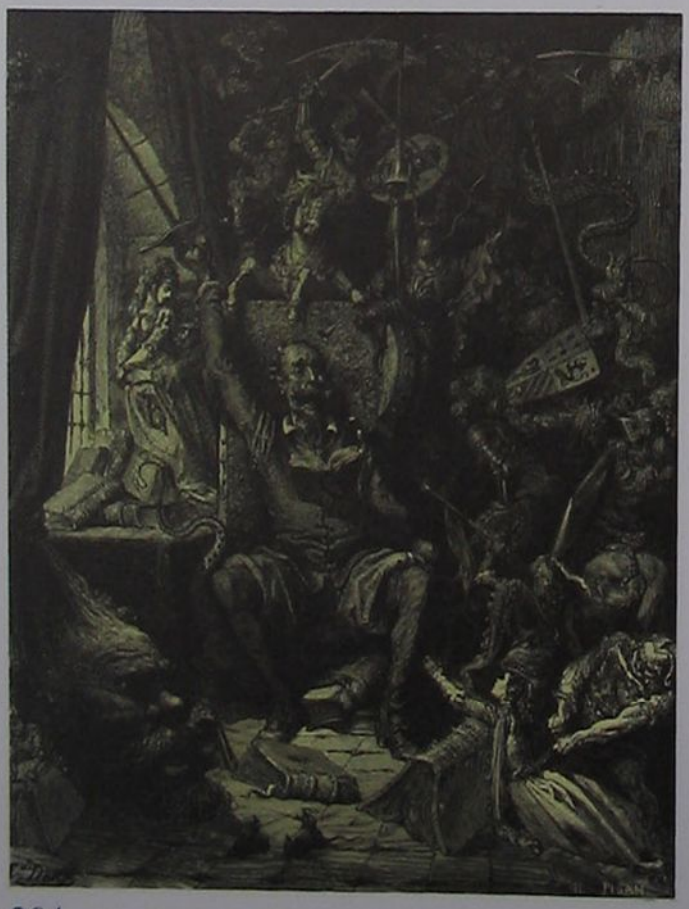
Reaping a harvest of barley in Alaska.



Europe and America. Wheat can grow in almost any climate, and most of the bread eaten by man is made from wheat (see Wheat). *Maize* is also known as *corn* or *sweetcorn*. It is a large grass, and bears its grain as long, yellow cobs. The cobs can be eaten baked or boiled, and they are also used to feed animals.

Barley grows in cooler regions. It is used mainly in making animal food and beer. *Oats* also thrive in cool and moist climates. Porridge is made by boiling oats in water, but oats are used mainly as animal food, especially for horses. *Rye* grows in poor soils and cold climates; it is used in the manufacture of certain types of bread and spirits. *Millet* is used to make bread in Asia, and is one of the most important cereals in Africa, but in Europe and America it is used as a food for cattle and poultry. *Sorghum* grows in warm climates and resembles maize. It is used mainly as an animal food, but sorghum grain can be made into flour.

Don Quixote, Cervantes' crackpot hero, in his study. His imagination became so filled with all he read, 'with enchantments, battles, challenges, and amours' that he lost his wits.



Cervantes, Miguel de (1547-1616), a Spanish author and dramatist, wrote the classic novel *Don Quixote*, which has since been translated into every major language. This delightful book follows the gallant Quixote and his peasant squire, Sancho Panza, through a series of misadventures in which each noble cause turns out to be ridiculous. The book is full of humour and sadness and gives a fascinating picture of Spain in the 1600's.

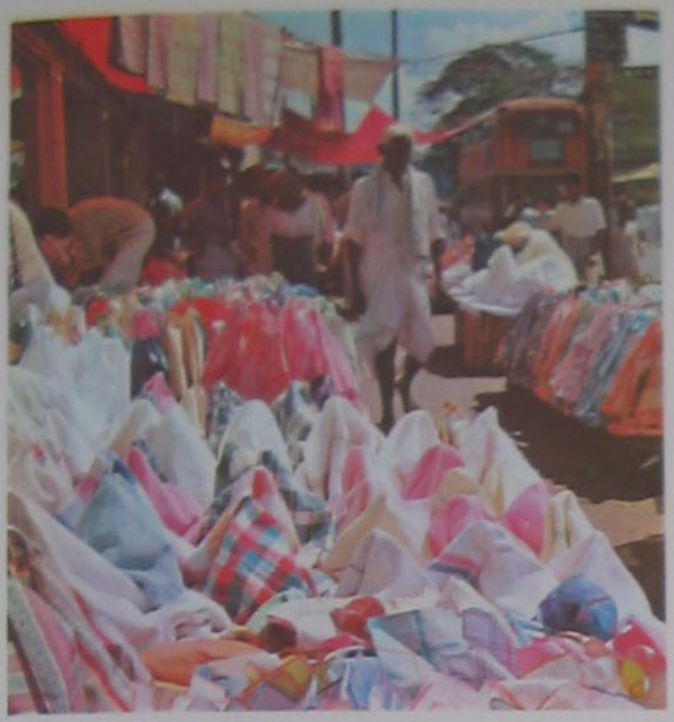
Cervantes was born in Alcalá de Henares. He had no formal education, but read widely. He suffered many misfortunes: injury in the Battle of Lepanto, capture by pirates followed by five years of slavery in Algeria, continual debts, and the failure of his first novel and many plays. Finally, the publication of the first part of *Don Quixote* in 1605 brought him fame. But his troubles continued because of unauthorized publications and fake versions. Cervantes published the second part of the novel in 1615, and continued writing until his death.

Ceylon is a beautiful island south of India in the Indian Ocean. It has many impressive temples and religious sculptures. Much of the island is made up of plains, but there are mountains in the centre and south. In 1972 it took the official name of Sri Lanka.

Ceylon is near the Equator, but it is seldom unbearably hot because sea breezes cool the land. Temperatures on the plains average about 80° F (27° C) throughout the year, and rainfall is heavy.

Mainly a farming country, Ceylon is second only to India in the production of tea. This one crop provides two-thirds of Ceylon's exports. Natural rubber is also important. Many precious stones, including rubies and topaz, are mined.

Ceylon has been invaded and colonized many times. As a result, many religions have been introduced into Ceylon. About two-thirds of the people of Ceylon are *Sinhalese*, who are Buddhists. Other



A stall selling handkerchieves makes a splash of colour in the market place at Colombo, Ceylon. A London bus, still in its original red paint, stands in the background.

groups include the *Tamils*, who are Hindus, the *Moors*, who are Muslims, and the *Burghers*, who are Christian descendants of Dutch and Portuguese settlers.

Buddhism was introduced from India in the third century B.C. The Portuguese introduced Christianity in the early 1500's. Nearly 150 years later, the Dutch took control of Ceylon. In 1802, Ceylon became a British Crown Colony. It became an independent country in 1948. After independence, religious and language differences led to strife between Christians and Buddhists, and Sinhalese and Tamils until the late 1960's.

Facts and Figures
Area: 25,332 square miles.
Population: 12,730,000.
Capital: Colombo.

Chad, a republic in north-central Africa, is named after Lake Chad. This huge lake lies on its western border, with Niger and Nigeria. To the north is Libya, while Sudan borders it on the east and Cameroon and the Central African Republic on the south. Chad has an area of 495,754 square

Above: Two dancers demonstrate traditional dances of Ceylon disguised by great masks.

Centre: Location map of Ceylon.

Below: Women tea pickers move slowly through the tea plantation picking the leaves and placing them in the baskets on their backs. Tea provides two-thirds of Ceylon's exports.

Location map of Chad.

miles, and a population of 3,500,000; the capital is Fort-Lamy.

In Chad's southern grassland live Bantu-speaking Negroes, most of whom follow tribal religions. In the north, covered by the hot dry Sahara, and the centre live Arabs and Muslim Negroes. Most of the people are farmers, and important products include rice, cotton, ivory, cattle hides and dates. Chad's economic development has been hampered by its land-locked position, and its government has many problems in uniting the different peoples. Chad, which became independent in 1960, was formerly a French colony and the official language is still French.

Chameleon is a strange lizard that can change colour to blend with its background. This makes it difficult to see. There are about 100 species, most of which come from Africa.

The chameleon lives in trees, and is slow-moving. It grasps twigs and branches with its feet and long, curving tail. It eats flies and other insects, which it catches by shooting out its 8-inch sticky tongue with tremendous speed. The chameleon changes colour by means of colour-containing cells beneath its skin. These react to changes of light and temperature, and the animal's emotions.

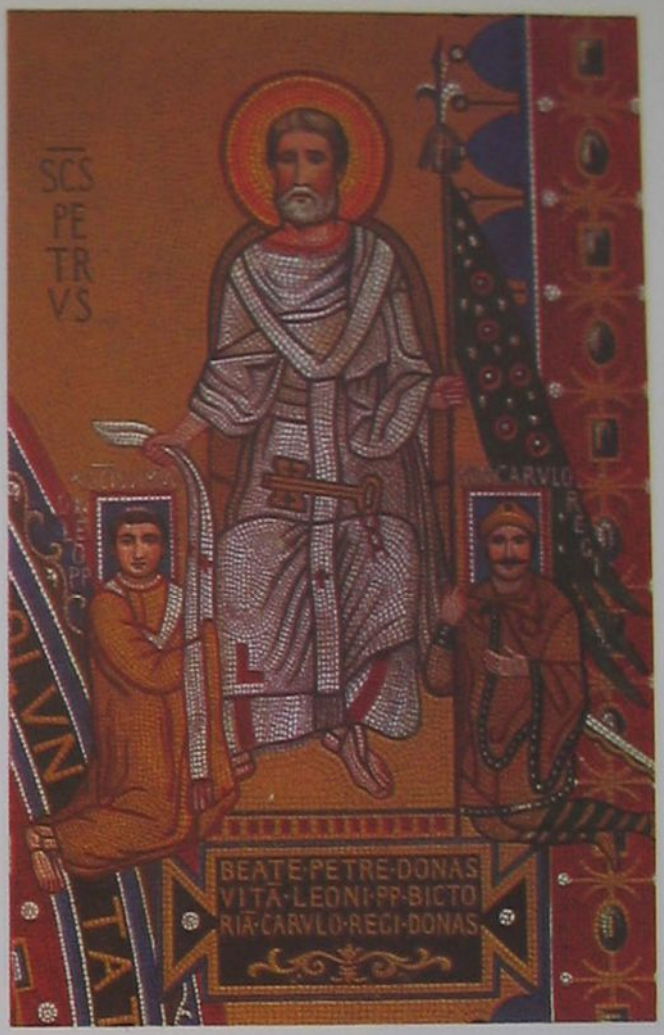
Channel Islands These islands lie in the English Channel close to the French coast. There are two large islands, Jersey and Guernsey, and seven smaller ones, Alderney, Sark, Herm, Brechou, Jethou, Lihou and Burhou. The principal towns are St. Helier (Jersey), St. Peter Port (Guernsey) and St. Anne's (Alderney). The Channel Islands are a United Kingdom dependency.

Farming is the most important industry and the people grow tomatoes and vegetables and raise cattle. Jersey and Guernsey cows are famous for their milk. The islands are popular holiday resorts.

The Channel Islands were part of the Dukedom of Normandy when the Normans conquered England in 1066. They still come under the British Crown, and the Queen rules them as Duchess of Normandy. They are largely self-governing. The people speak English and old Norman-French. The islands were occupied by the Germans during World War II.

Chaplin, Charlie (1889-), gained world fame as a film comedian. Born in London, he began his career as a music-hall actor. In 1910 he went to America, and from 1915 made many silent films. He created the part of a little tramp in baggy clothes, a bowler hat, and carrying a bamboo cane, whose comic antics and bewilderment

Charlie Chaplin (left), possibly the greatest film comedian of all time, with two friends.



Above: Charlemagne's crown. Right: A mosaic in the Lateran church, Rome, depicts St Peter above Leo III and Charlemagne.

with the world about him amused film audiences everywhere. Among the many silent films in which he appeared were *Easy Street, The Immigrant, The Kid,* and *The Gold Rush.* Chaplin formed his own film company in 1918 and wrote and directed all his later films. After sound was added to films he made fewer pictures, but they included such successes as *Modern Times, The Great Dictator,* and *Limelight.*

Charlemagne (A.D. 742-814) was a powerful ruler who became the first Holy Roman Emperor. He was a great military leader, but was also a champion of learning and the arts.

At 29, Charlemagne became king of the Franks. His kingdom consisted at that time of France and part of Germany. His first major war was fought against the Lombards. These were a Gallic people who had invaded Italy in the late sixth century and been a source of trouble to the popes ever since. At the request of Pope Adrian I, Charlemagne crossed into Italy, overthrew the Lombard king, and added this territory to his own.

His most important war was fought against the Saxons, a *pagan* (idol-worshipping) people who held north-western Germany. This war lasted for 12 years. Charlemagne's victory opened the way for the religious conversion and civilization of Germany.

While the Saxon war was still going on, the Romans threatened to depose Pope Leo III. Again Charlemagne marched into Italy to defend the Catholic Church. On Christmas Day in the year 800, the Pope crowned him Holy Roman Emperor.

Charlemagne encouraged interest in the arts, philosophy, and education. He was one of the founders of European civilization. Although his empire broke up after his death, his accomplishments had a lasting influence.

Charles was the name of two Stuart kings of England, Scotland, and Ireland.

Charles I (1600-1649) became king in

Right: Charles I, crowned in 1625, whose obstinate belief in his 'divine right' to rule led to the English Civil War. Above: Charles II, who ruled from 1660 to 1685, brought culture and art to Britain after the austerity of the Commonwealth.

1625, on the death of his father, James I. He offended his Puritan subjects by marrying a Catholic, Henrietta Maria, the sister of King Louis XIII of France. Charles believed that he ruled by divine right—that God had appointed him and his family before him to rule. His reign became a struggle with Parliament, principally over money and religion.

In 1628, Parliament presented the Petition of Right. By accepting the Petition the King promised never again to raise money without Parliament's consent, and not to imprison anybody except in accordance with the law. But in 1629 Parliament was dissolved and for 11 years Charles ruled without it. In 1640 he had to recall Parliament to try to raise money to fight the Presbyterian Covenanters in Scotland who opposed his Church policy.

In 1642, the rift between the King and the Puritans in Parliament resulted in civil war. The King's army was defeated by Oliver Cromwell's New Model Army and an alliance between the Royalists and the Scots ended in further defeat. In 1649 Charles was tried by a special court, which sentenced him to death for treason and tyranny. He was publicly beheaded in London, going bravely to his death. The country became a republican Commonwealth, and later a Protectorate with Cromwell as Lord Protector.

Charles II (1630-1685), son of Charles I, was crowned king by the Scots in 1651. That year he invaded England, but was routed by Oliver Cromwell at Worcester. After many narrow escapes, Charles reached France. Later he lived in Germany and the Netherlands.

Here lies our sovereign lord the king whose promise none relies on; He never said a foolish thing, Nor ever did a wise one.
The Earl of Rochester's epigram on Charles II

This is very true: for my words are my own, and my actions are my ministers'.
(Charles's reply to the Earl of Rochester)

In 1660, two years after the death of Oliver Cromwell, Charles was welcomed back to England, where he was proclaimed king. His return marked the start of the period called the *Restoration*. It was noted for a revival of interest in the arts which had been suppressed under the Puritans.

Charles's court became known for frivolity, wit and scandalous living. He was a clever politician, and was determined to free himself from parliamentary control without plunging the country into another civil war. He managed to do so by accepting money from his cousin, King Louis XIV of France, in return for supporting French policies in Europe. The Great Plague and the Great Fire both occurred in Charles's reign.

Chaucer, Geoffrey (1340?-1400), was an English poet whose works are today regarded as classics. The language he wrote in has become the basis of modern English. Chaucer was born in London, the son of a wine merchant, John Chaucer. As a boy he was for a time a page in the service of Lionel, later Duke of Clarence. In 1359 he went with the English army under Edward III to France, where he was taken prisoner. He was soon ransomed, however, and returned to England, where he married Philippa, daughter of Sir Payne Roet and sister of John of Gaunt's wife. He held various positions at court and in the service of the king.

In 1369, Chaucer wrote *The Boke of the Duchesse*, which shows signs of French influence. In 1372 he was sent on a mission to Genoa and Florence, where he might have met Boccaccio and Petrarch, whose poetry, together with that of Dante, certainly affected his development as a writer. The *Parlement of Foules* and *Troylus and Cryseyde* were written soon after this Italian visit.

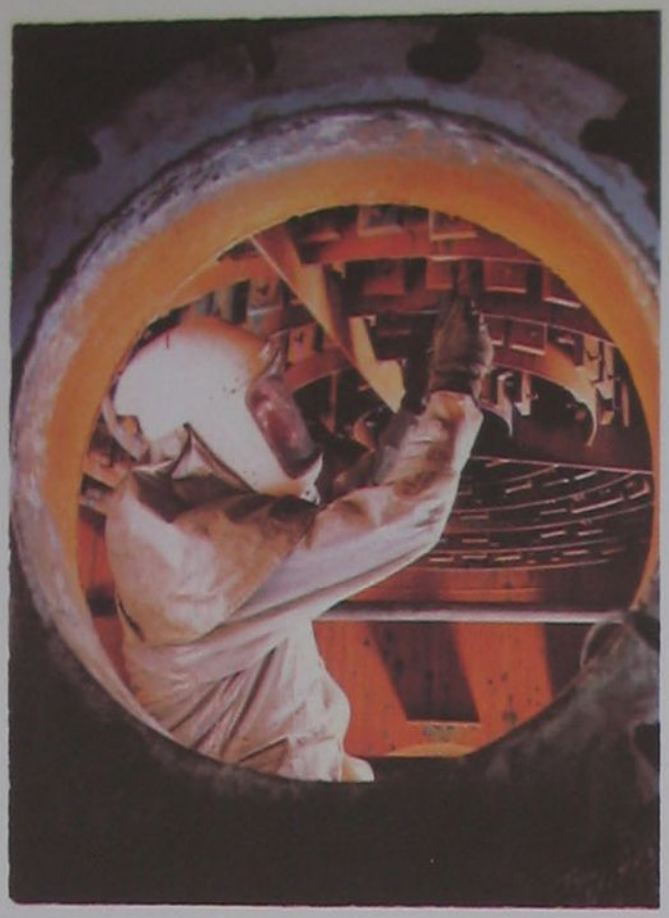
A knyght there was a worthy man
That fro the tyme that he first began

Above: A woodcut of the knight illustrates an edition of *The Canterbury Tales* published in about 1490. The woodcut was made by an artist named Richard Pynson. Right: A portrait of Chaucer.

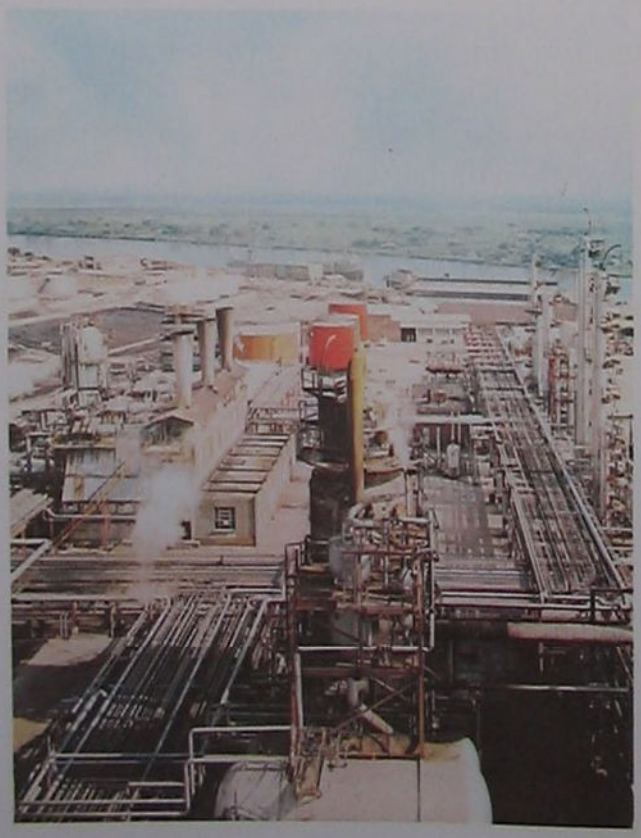
Chaucer was appointed Controller of Customs in the port of London in 1374, and lived in the house above Aldgate. Two years later he was sent on secret service to Flanders, after which he was attached to embassies to France and Lom-

The verse below is Chaucer's description of the miller in 'The Canterbury Tales'. It is written in the language Englishmen spoke 600 years ago. How much of it can you understand?

The Miller was a stout carl, for the nones,
Ful big he was of braun, and eek of bones
That proved weel, for over-al there he cam,
A wrestling he wolde have alwey the ram.
He was short-sholdred, brood, a thikke knarre,
Ther was no dore that he nolde heve of barre,
Or breke it, at a renning, with his heed.



Above: A technician has to enter a chemical reaction vessel to service it. He wears special clothing and breathing apparatus to protect himself from fumes. Below: A petroleum refinery is a huge chemical plant. A maze of pipes connects the towers in which the refining operations take place.



bardy. In 1386 he sat in Parliament as knight of the shire for Kent.

In April, 1388, Chaucer went on a pilgrimage to Canterbury, which must have suggested material for his most famous work, the *Canterbury Tales*. This is a collection of stories told by people whom he describes going on a similar pilgrimage. Chaucer wrote these tales in the dialect used in London, which of all the dialects then spoken, became the basis of modern English. At about this time he was Clerk of the King's Works, and a year before his death he became Deputy Forester. He was buried in Westminster Abbey.

Chemicals The chemical industry covers a vast number of industries which manufacture products by means of chemical processing. It includes the *heavy* chemical industry, which produces enormous quantities of such basic chemicals as sulphuric acid, caustic soda (sodium hydroxide), ammonia, chlorine and nitric acid. These chemicals, especially sulphuric acid, are used not only throughout the chemical industry but in practically every other industry as well.

The petroleum and coal industries produce *fine* chemicals which are used as raw materials in many branches of the

SOME HOUSEHOLD CHEMICALS

Acetic acid	vinegar
Acetyl salicylic acid	aspirin
Alcohol	methylated spirits
Ammonium carbonate	smelling salts
Ammonium hydroxide	household ammonia
Ammonium sulphate	fertilizer
Calcium hydroxide	garden (slaked) lime
Carbolic acid (phenol)	disinfectant
Carbon tetrachloride	dry cleaning fluid
Ethylene glycol	antifreeze
Hydrogen peroxide	bleach, disinfectant
Magnesium oxide	milk of magnesia
Magnesium sulphate	Epsom salts
Mercurous chloride	calomel
Nylon	synthetic fibre
Polyethylene	plastic
Potassium aluminium sulphate	alum
Potassium tartrate	baking powder
Sodium bicarbonate	baking soda
Sodium carbonate	washing soda

chemical industry. They form the starting point for such things as plastics, synthetic fibres, detergents, and, not least, drugs. The drug, or *pharmaceutical*, industry produces everything from aspirins to anaesthetics, vaccines to vitamins.

All these different industries use different raw materials and different methods of processing. But the production of any chemical substance can be broken down into several basic steps. Raw materials are prepared and mixed, a chemical reaction takes place, and a product is separated and purified. This involves a number of basic chemical and physical processes called *unit operations*. Distillation, mixing, crystallization and heat transfer are typical unit operations. Many modern chemical plants are under automatic control (see Automation).

Chemistry is the study of the properties and make-up of substances and of the changes they undergo. There are three main branches. *Organic* chemistry is concerned with the compounds of the chemical element carbon. Carbon forms more compounds than any other element because its atoms can combine with one another to form long chains. These compounds are the basis of all living matter. *Inorganic* chemistry is concerned with the compounds of all the other elements. *Physical* chemistry includes the study of the physical properties of compounds and the physical changes that occur during reactions. (See Biochemistry.)

Cheshire, a county in north-west England, is noted for its fine cheese. Its county town is Chester, and its area is 1,015 square miles.

A short stretch of the county, the Wirral Peninsula, borders the Irish Sea in the north-west. The land is mainly rather flat and well wooded, with numerous lakes. To the east, the Pennines rise abruptly. The main rivers are the Dee, Mersey and Weaver. Dairy farming is important; and salt, mostly extracted

Pupils conducting experiments in a modern school laboratory. At the beginning of the 1900's, chemistry was rarely taught in schools; today it is one of the major subjects and nearly every school has a well-equipped science 'lab'. Practical experiments help the students to understand what substances are and why they behave in the ways they do. A chemist needs plenty of patience—some scientists spend years trying to solve a single chemical problem.

Above: An old print shows that chess has been a popular game for centuries and that it was played in the past as it is now. Right: An elegant chess set carved in ivory was found on the Isle of Lewis in the Hebrides, Scotland. This piece is the knight and the set dates from about A.D. 1150. Below: Chess was first played in the East but it has now spread to the West. These American boys are just three of the nine million Americans who play chess.

as brine, is produced at Northwich, Middlewich, Winsford and Sandbach. The saltworks encouraged the development of chemical industries along the Weaver and Mersey. The chief towns are Chester, Birkenhead (linked to Liverpool by the Mersey Tunnel), Stockport, Wallasey, Crewe and Macclesfield (famed for its silks).

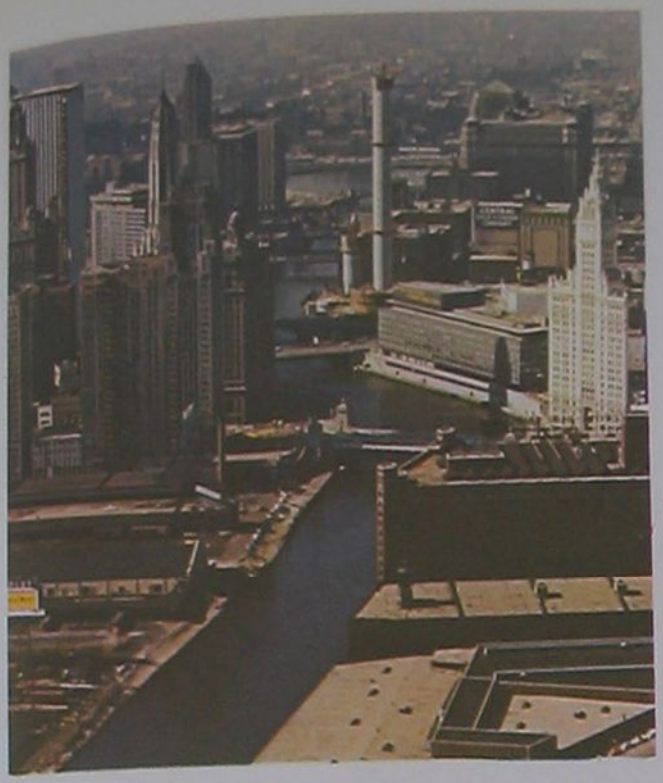
Chess This complex board game, which simulates warfare, is almost as old as civilization. It is played on a board of 64 squares, alternately white and black, arranged so that each player has a white square at his near right-hand corner. Each player has sixteen pieces, coloured white or black, and he arranges these in the two rows nearest him, using every square. From left to right on the back row the pieces are: Rook (or Castle), Knight, Bishop, Queen, King, Bishop, Knight, Rook. On the second row are all eight Pawns. Each piece has different powers of movement.

The object is to force the enemy King into submission. The King is the only piece never actually taken, but when threatened he is 'in check' and must move in any direction to an adjacent square if unoccupied by any pieces, or he may remove the attacking piece, or interpose one of his own. If he cannot do this freely it is 'checkmate' and the game is finished.

In the process of attacking the King, each player attempts to weaken the enemy forces by capturing pieces.

Chicago is a city on a vast scale that has grown rapidly from small beginnings. In the early days of the United States it was a jumping-off point for explorers and fur traders. Today, as America's second largest city, it has, with its suburbs, a population of nearly 7 million.

Chicago is in the state of Illinois, and stretches more than 20 miles along the shores of Lake Michigan. It is at the centre of a vast farming region, and contains one of the largest grain markets



Chicago is the second largest city in the United States. The North Chicago River, criss-crossed by bridges, winds inland from Lake Michigan through a forest of sky-scrapers.

in the world. It is also one of the largest manufacturing regions in the United States. It is a major communications centre, with a port and three airports.

There are many communities in Chicago whose people came originally from various parts of the globe, such as Germany, Ireland, Italy, and Poland. Negroes make up nearly a quarter of the city's population.

The Great Chicago Fire (1871) destroyed most of the wooden buildings, but the city was rebuilt in stone and steel.

Chile, a country on the west coast of South America, is a long, narrow strip of land. Much of its eastern border runs through the Andes mountains (see Andes). Hot deserts lie in northern Chile, and cool, wet forests cover the south. The central area has warm, fertile valleys and most of the people live there.

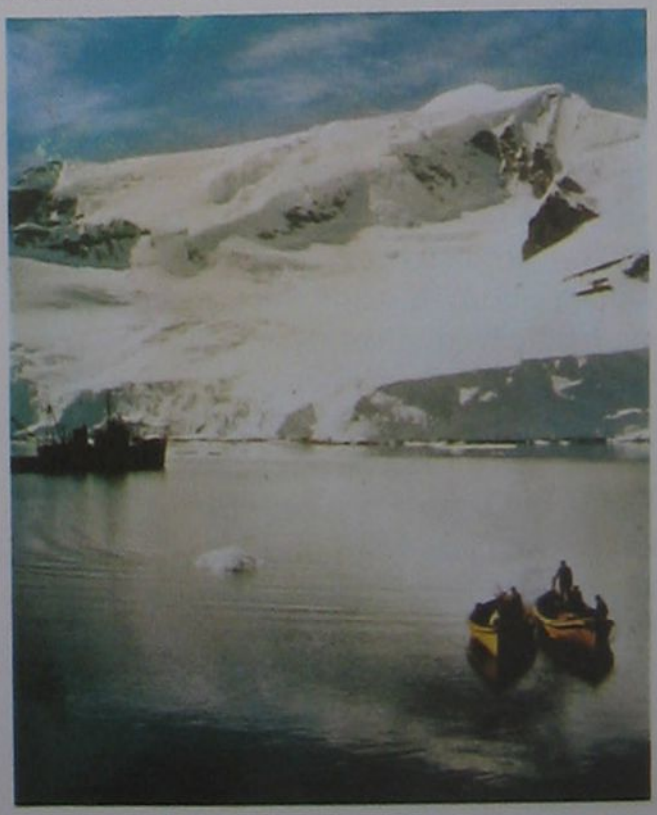
Southern Chile has many islands. The large island of Tierra del Fuego belongs partly to Chile and partly to Argentina. Its name means *land of fire*. The Portuguese explorer Ferdinand Magellan gave it this name when he saw from his ship the cooking fires of American Indians.

Location map of Chile.

Most Chileans are *mestizos*—people of mixed Spanish and American Indian descent. Chile's cities are modern. The country is one of the leading industrial nations of South America.

Outside the cities, the poorer people live in mud huts and work on farms, where sheep produce wool for export. Others work in mines extracting copper, iron ore and nitrates, which make up three-quarters of the value of Chile's exports.

Chile stretches for 1,700 miles along the west coast of South America. Although the climate in the north of the country is hot and arid, in the south it is cool and wet, and snow may fall in the winter.



After gaining its independence from Spain in 1818, Chile was involved in disputes with Bolivia and Peru over ownership of the nitrate mines. Today Chile is one of the most settled South American countries, although its cities and towns have suffered much damage from earthquakes and tidal waves. In 1960, earthquakes killed nearly 2,000 people.

Facts and Figures
Area: 286,397 square miles.
Population: 8,834,000.
Capital: Santiago.

China is the world's third largest country and it contains more than a fifth of the world's people. After 3,000 years of brilliant achievements, China was outstripped by European science and technology about 300 years ago. China is now rapidly catching up other countries.

Mainland China is ruled by the communist government of Peking. The island of Formosa (Taiwan) is governed by Nationalist Chinese, who retreated to the island after the civil war which ended in 1949.

Mountains and deserts encircle China. Stony deserts extend westwards from Manchuria across Chinese Inner Mongolia, into the isolated region of Sinkiang. To the south, China's mysterious region of Tibet, called the 'roof of the world', towers more than 12,000 feet above sea level. Much of China is covered by mountains and small river valleys.

Most Chinese are farmers who live in the valleys of the great rivers and their tributaries. A third of the people depend on China's greatest river, the Yangtze, for their livelihood. North of the Yangtze lies China's second great river, the Hwang Ho. The name means 'Yellow River', because it washes the fine, yellow soil called *loess* from northern China into the Yellow Sea. Called 'China's sorrow', the Hwang Ho has often changed its course, bringing ruin and death to the farmers. But the Hwang Ho is used to irrigate the loess soils of the North China plain, China's most fertile region.

Most of China is hot in summer and cool or cold in winter. About 80 inches of rain falls in southern China in most years, but the north has only 40 inches. Little rain falls in China's interior.

China's farmers produce a large variety of crops. Wheat and millet are the main food crops in the north, rice in the south. Farmers also rear many animals, but most Chinese eat little meat. They consider that land is too valuable for animals and that they get more food-value from crops.

Although China's vast mineral wealth remains largely unexploited, it is fast becoming an industrial nation. Many country people are moving into its great cities, such as China's capital, Peking, or the great port of Shanghai.

Before the 1940's, Chinese society was centred on the family and dominated by the three religions—Confucianism, Taoism and Buddhism. But after China became a communist country in 1949, family farms were amalgamated into *collective farms*. Since the mid-1960's, most of China's farmers and industrial workers have lived and worked together in communes. In communes people own little private property. They aim to create wealth for their children and grandchildren rather than for themselves.

China has the oldest continuous civilization in the world. For some 3,500 years it was ruled by a series of royal families, or *dynasties*. The earliest recorded dynasty, the Shang, lasted from *c.* 1500 to *c.* 1027 B.C. Bronze working was perfected during this period and kaolin (pure white clay) was discovered by Chinese potters. The first writing was scratched on turtle shells. The Chous replaced the Shangs in the eleventh century B.C. During their rule,

The population of China is estimated to be over twenty per cent of the world total. The density of population is also high with over 300 people per square mile in the rural areas and up to 3,000 people per square mile in the semi-rural areas around the deltas of the Yangtze and Hwang Ho rivers. About 10 million Chinese are born every year, which works out at roughly three births every second.

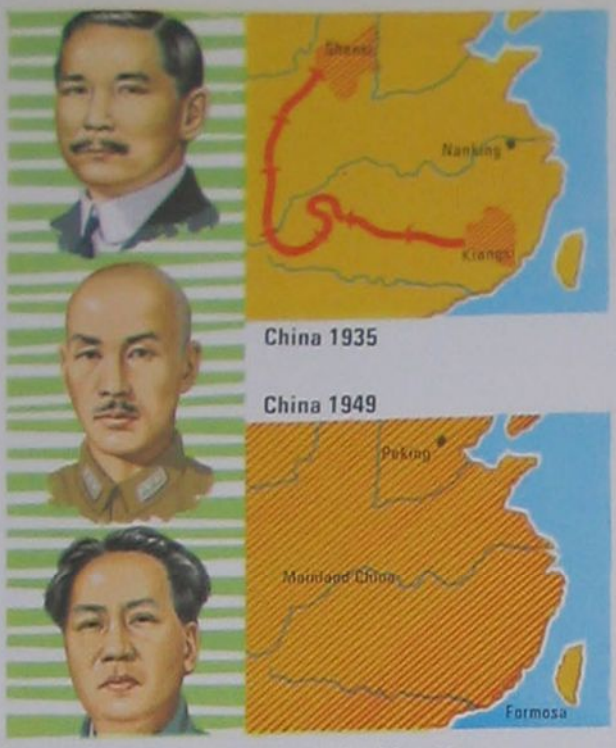
Chinese workers reciting the thoughts of Chairman Mao Tse-tung from the 'little red book' during the cultural revolution. They are led by a young soldier of the Red Guard. A portrait of Mao Tse-tung is in the background.

the knowledge of iron spread, and iron hoes and axes were used. In 479 B.C. China broke up into a number of warring states. Two great Chinese teachers lived at this time: Laotzu, who created Taoism, and Confucius.

China was reunited in 221 B.C. by the Chins (see Great Wall of China). The greatest of all dynasties, the Han, followed; the Chinese called themselves 'Sons of Han'. Han China covered an even larger area than China today. Chinese society reached a peak under the Hans (206 B.C. to A.D. 220). The family was the most important unit; ancestor worship was the centre of all Chinese religion. A Civil Service, chosen not by birth but by examination, ruled under the emperor. They were called Mandarins. They studied Confucius and practised writing and painting. Merchants flourished in the growing cities, and roads were built with post offices and inns at regular intervals. The Han dynasty fell when the peasants rebelled against the cost of these improvements.

Between A.D. 618 and 907 China was reunited by the Tangs. Chinese foreign trade grew during this period, and the Chinese overseas are still called 'the people of Tang'. Printing was also invented at this time. After a brief collapse, the Sungs reunited China (960 to 1279). Bank notes are a Sung idea. From 1279 to 1368 the Yuan dynasty, founded by Kublai Khan (see Kublai Khan; Mongols), ruled China. The native Chinese Mings drove out the Mongols. China produced lovely porcelain in the Ming period (1368 to 1644). We call our crockery 'china' to this day. In 1644 a branch of the nomad Mongols set up the last dynasty, the Manchu. They imposed pig-tail wearing on the Chinese.

The foreign Manchu emperors were always hated by the Chinese. There were many revolts until in 1911-12 a national movement led by Sun Yat-sen overthrew the last emperor and proclaimed a republic. China had been weakened by strife, and many of her ports had been occupied by foreign powers. Between



Sun Yat-sen (top) overthrew the Manchu dynasty in 1912 and formed a Chinese Republic. In the 1920s, the Kuomintang, led by Chiang Kai-shek (centre), came to power. Mao Tse-tung (bottom), the leader of the Communists, opposed Chiang and established Communism in Kiangsi province. In 1935 Chiang forced Mao and his supporters to leave Kiangsi and undertake a great march to Shensi, 6,000 miles away. But by 1949 Chiang had been driven to refuge on the island of Formosa or Taiwan, and the vast mainland was under Communist control.

Chinese art has been considered to be among the world's finest for thousands of years. Right: A pottery model of a watch tower dates from the Han dynasty (206 B.C. to A.D. 220). Below right: A figure of a saddled horse found in a tomb. It is made of glazed pottery with blue splashes, and dates from the T'ang dynasty (A.D. 618-960).

Rice is the main crop in the south of China. Workers wade through the paddy fields, planting the young shoots of rice.

Facts and Figures
Area: 3,691,502 square miles (mainland); 13,885 square miles (Formosa).
Population: 759,600,000 (mainland); 14,753,000 (Formosa).
Capital: Peking (mainland); Taipei (Formosa).
Exports: coffee, cotton, iron ore, sugar.
Imports: chemicals, fuel, machinery.

the World Wars, China was attacked by Japan and torn by civil war between the Kuomintang, led by Chiang Kai-shek, and the Communists, led by Mao Tse-tung.

By 1949 the Communists had won. They were determined to end the backwardness of China and make her a world power once more. Since then, a Chinese form of Communism has developed. Great simplicity of living and hard work for the public good is preached. Mao Tse-tung's ideas are taught to all through a little 'red book' of extracts from his writings. (See Mao Tse-tung.)

A border dispute in 1969 with the U.S.S.R. nearly led to war. In 1971 China began to restore normal relations with the rest of the world. The following year U.S. President Nixon visited Peking and had friendly talks with the Chinese leaders. Other Western leaders soon followed his example and China was admitted to the United Nations

Left: Mao Tse-tung brought Communism to China and improved the standard of living. His ideas are taught to all by means of a little red book containing his 'thoughts'. In 1967, there was virtual civil war when young Red Guards set about enforcing what they claimed to be the thoughts of Chairman Mao.

Location Map of China.

Talking points
*China and the U.S.S.R. are both Communist countries. Why do you think that they are on unfriendly terms with each other?
*Many Chinese live in communes. How has this affected family life in China?
*In 1949 China had been devastated by eight years of war with Japan and three years of civil war. Today she is a major world power. What factors do you think have enabled her to make such a dramatic recovery?

Articles to read
Communism; Confucius; Formosa; Great Wall of China; Hwang Ho; Mao Tse-tung; Peking; Yangtse.

Chlorophyll is a green pigment found in the leaves and stems of almost all plants. Chlorophyll is packed in tiny envelopes called *chloroplasts*, which lie in the food-making cells in the leaves and stems. Its function is to absorb light energy and convert it into chemical energy needed to split water molecules in the first stage of photosynthesis—the synthesis of sugar and starch.

Chopin, Frédéric François (1810-1849), was a Polish composer and pianist. In 1830 he left Warsaw and settled successfully in Paris. In 1838, he visited Majorca for health reasons, accompanied by the French woman novelist, George Sand. Shortly before he died of tuberculosis, he gave several recitals in Scotland and England.

Almost all Chopin's works were for solo piano. They include waltzes, studies, nocturnes and compositions based on Polish dance rhythms, such as polonaises and mazurkas.

A sketch of the Polish composer Frédéric Chopin. He wrote almost entirely short pieces for the piano. The folk music of his native country had an important influence on his work.

Christchurch is New Zealand's third largest city after Wellington and Auckland. It lies near the eastern coast of South Island, in a flat part of the Canterbury Plains. Its port, Lyttelton, lies 7 miles to the south-east. Christchurch is the capital of Canterbury province, and has a population of 260,200.

Christchurch is laid out in a grid plan with Cathedral Square, site of the Gothic-style Anglican cathedral, at the centre. Everywhere, green parks and gardens can be seen. The city is noted for its fine schools, and for the University of Canterbury. It also has art galleries, a museum and libraries.

Christchurch has important industries. Manufactures include processed foods, leather, wool and flour. Factories also produce clothing, carpets, and transport and electrical equipment.

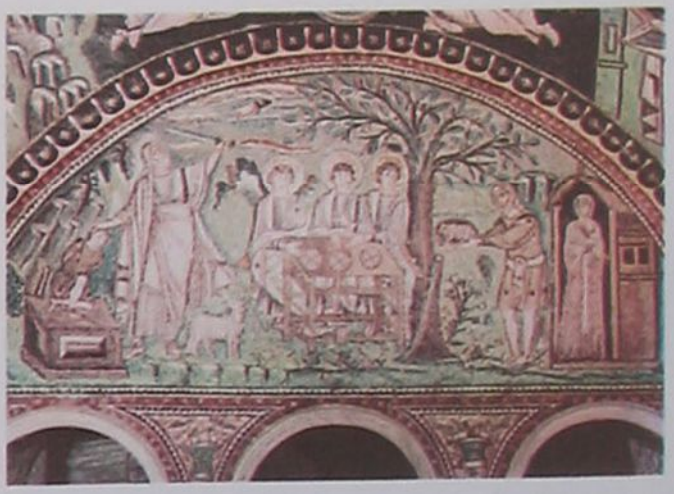
Christchurch was founded in 1850. Its settlement was sponsored by the Canterbury Association of churchmen and landowners in England, who built Christchurch to resemble an English city. It keeps much of its English character today.

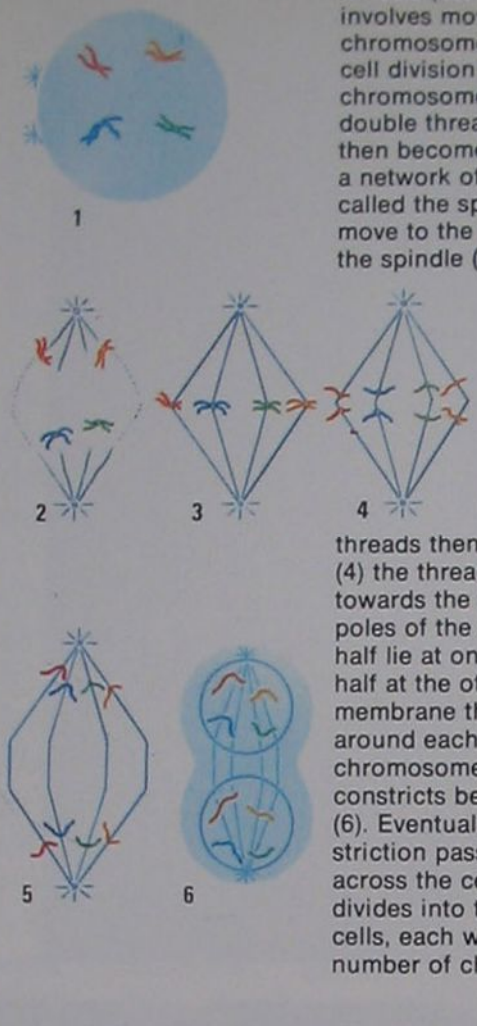
Christianity is the religion of those who follow the teaching and example of Jesus Christ and believe in His divinity. Christians accept the Bible as their holy book and preserve Sunday as their holy day or Sabbath. Most Christians participate in the fellowship of the Church, their place of worship. The main Christian festivals are Christmas, celebrating the birth of Jesus, and Easter, commemorating His death and resurrection.

Christianity has its origin in ancient Jewish tradition, whose prophets had promised the Coming of the Messiah. When Jesus was born in Bethlehem, he was accepted by some as this saviour. He became famous as a teacher and healer, assisted by his group of twelve apostles. He preached a doctrine of universal love and brotherhood.

What is known of Jesus's life is contained in the four gospels written by Matthew, Mark, Luke and John. The remaining books of the New Testament describe how Christianity spread, and

The story of Christ and events from the Bible and the lives of saints were the most important subjects of expression in all forms of Western art until recent times. The way in which Christian religious feeling are portrayed may vary immensely. Above: This 16th-century painting by El Greco shows Christ kneeling before an angel. Right: Mosaics are an older form of art and some of the best Christian mosaics are to be found in Northern Italy. This mosaic is in the Basilica di San Vitale at Ravenna, and portrays Abraham and the sacrifice of Isaac. Below: Sculpture can express the power of Christianity, as in this statue of Christ Redeemer at Rio de Janeiro, Brazil. Below right: An embroidered altar frontal dating from 1400 shows scenes from the lives of several saints.





Mitosis (cell division) involves movement of chromosomes. Soon after cell division starts, the chromosomes appear as double threads (1). They then become arranged on a network of strands, called the spindle (2), and move to the equator of the spindle (3). The double threads then split apart (4) the threads moving towards the opposite poles of the spindle until half lie at one end and half at the other (5). A membrane then forms around each set of new chromosomes and the cell constricts between them (6). Eventually the constriction passes right across the cell and it divides into two new cells, each with the full number of chromosomes.

expand on Christ's teaching. Jesus's claims to divinity angered many people, and in about A.D. 29 He was condemned to death by Pontius Pilate, the Roman governor, and crucified. Christians believe that three days later He arose from the dead and later ascended into Heaven.

The teaching of Jesus quickly spread throughout the known world. St Paul, in particular, travelled to many countries as a missionary. Christianity was an established religion in Rome by the early 300's and was carried to many parts of the Roman empire. In 1054 the religious centre of Constantinople, now Istanbul, refused to accept the supreme authority of the pope in Rome and formed the Eastern Orthodox Church. In the 1500's the Reformation brought about the division of Western Christianity into Roman Catholics and Protestants. Today the world's Christians, numbering almost 1,000 million, are divided into more than 300 denominations. Since the 1800's the *ecumenical movement* has striven to unite them.

Chromium The most familiar use of chromium is as a thin, protective coating over other metals such as nickel, steel, and zinc. Chromium plating is hard and stays shiny because it does not rust or tarnish like most metals. Chromium is not used alone because it is too brittle. Many automobile parts, such as the fenders, or bumpers, are chromium plated.

The biggest use of chromium, however, is in alloys with other metals. It is added with nickel to steel to give the rust-proof stainless steels which we use for cutlery and kitchen utensils. Certain nickel-chromium alloys have great resistance to damage by heat. They are used for heating elements in electric fires and for jet-engine parts.

Chromosomes are tiny thread-like parts of a cell's nucleus. (See Cell.) They contain *genes*, the sets of inherited instructions that control the shape and function of the cell and of the complete living creature. Both plants and animals have chromosomes. Each *species* (kind) of creature has a characteristic number, made up of pairs of similar-looking threads. For example, man has 23 pairs and pea plants 7 pairs in each cell nucleus. In fact, a woman has 23 pairs of identical chromosomes – including a pair known as the X chromosomes – while a man has 22 pairs plus a single X chromosome and an odd one called a Y chromosome.

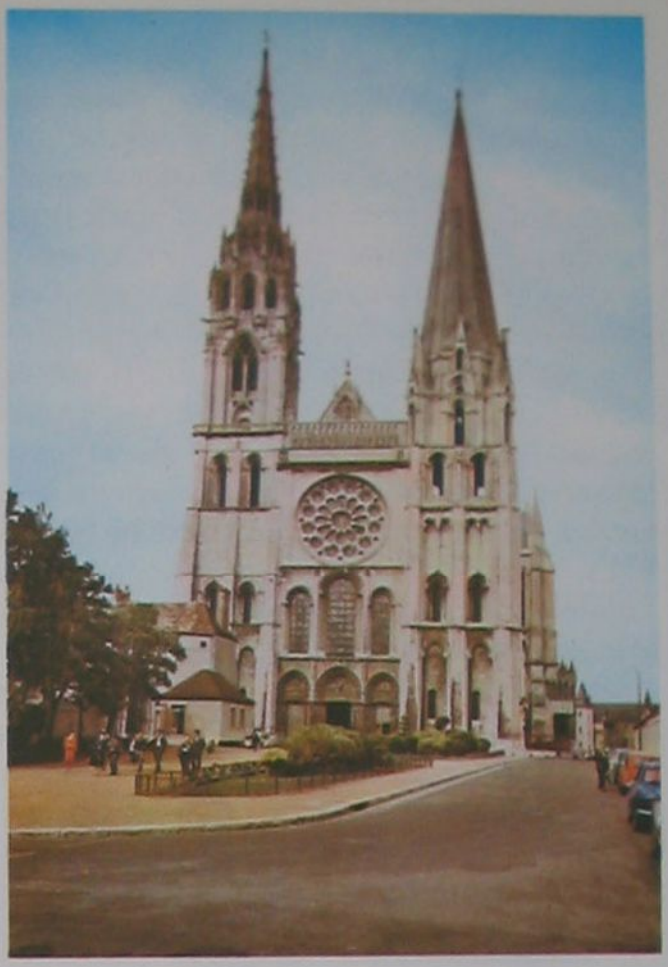
Churches are buildings where Christians meet to worship. They usually face the east (the altar end), and the main entrance is by the west door. The buildings are often cross-shaped *(cruciform)* with the arms of the cross forming the *transepts*. The *nave* seats the congregation, and this word comes from the Latin *navis*, meaning

a *ship*, because the church was seen as the vessel that carried believers across the sea of life to the harbour of heaven.

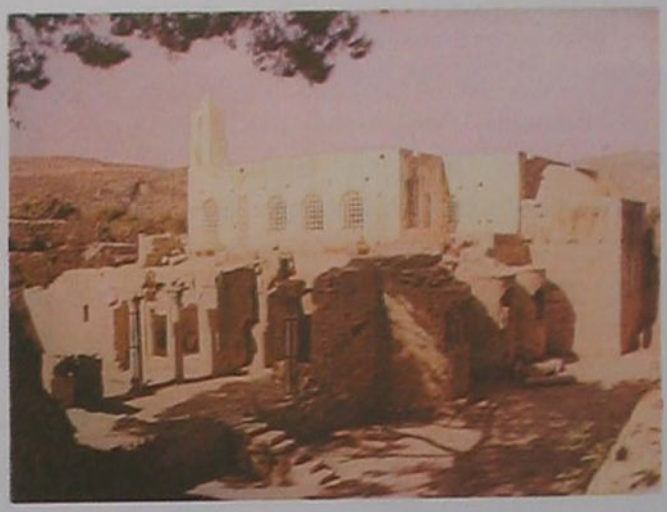
The *aisles* on either side of the nave are often divided from it by rows of pillars, above which there is often a series of arches called the *triforium*, and a row of small windows called the *clerestory*. The *chancel* leading to the altar is divided off by a carved screen. The part containing the altar is called the *sanctuary*.

Many changes in the style and decoration of churches have taken place over the centuries. Styles are usually mixed as one period passed into another. Broadly speaking, the Saxon period extended from A.D. 700-1050, but few wooden Saxon churches are left.

The Norman period, A.D. 1050-1190, followed the Saxon, when towers were placed on churches after the continental style. Early English (1190-1280) followed, succeeded by the Decorated style (1280-1360), and finally the Perpendicular



Above right: The cathedral at Chartres, France, thought by many to be the finest of all Gothic churches.
Left: A monolithic church made out of rock during the 1100's at Lalibala, Ethiopia. Below: The interior of a church in Denmark. Right: The church of St. Nicolas at Demre in Asia. Below right: An old Byzantine church near Nigde in Turkey.



(1360-1540). Early English or Gothic churches were higher and more graceful than the Norman, with lofty spires like those of Salisbury Cathedral, England.

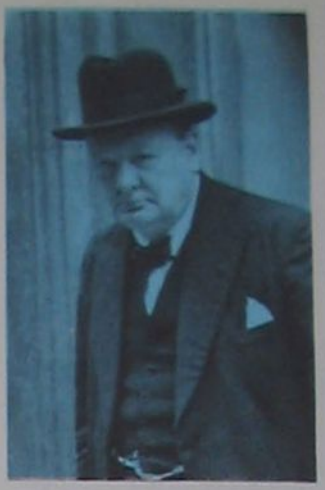
During the 14th century many magnificent churches were 'decorated' with stone carvings (hence the name). Ely Cathedral in Cambridgeshire, England, is a good example. From 1360 the grand perpendicular style took the place of the flowered carving and tracery of the decorated manner. It gets its name from the straight upward lines of the vast windows and arches. It is seen at its loveliest in Henry VII's chapel in Westminster Abbey, London, and Kings College Chapel, Cambridge, England.

After about 1600 came a mixed Gothic and classical revival of which Inigo Jones's chapel in Lincolns Inn, London, is a good example. His St. Paul's, Covent Garden, London, is another in the classical manner. Modern churches are simpler and plainer, on the whole, though some are experimental, planned round a centrally placed altar.

Churchill, Sir Winston Leonard Spencer (1874-1965), was one of the greatest leaders in English history. His finest achievements were as British prime minister during the Second World War from 1940 to 1945. He was also one of the world's most eloquent speakers and writers.

Churchill was born at Blenheim Palace, in Oxfordshire. He was educated at Harrow School and Sandhurst military academy. He joined the 4th Hussars and served in Cuba, India and the Sudan. He left the army for South Africa where he wrote reports on the Boer War for a London newspaper. He was captured by the Boers but escaped.

We shall not flag or fail. We shall fight in France, we shall fight on the seas and oceans, we shall fight with growing confidence and growing strength in the air, we shall defend our island, whatever the cost may be, we shall fight on the beaches, we shall fight on the landing grounds, we shall fight in the fields and in the streets, we shall fight in the hills; we shall never surrender.
(Winston Churchill in a speech in the House of Commons, May 1940)



Left: A picture of Sir Winston Churchill taken when he was prime minister. Below: One of Churchill's relaxations was brick-laying. During the Second World War, he built a wall at his country home at Chartwell in Kent.

In 1900 Churchill was elected a member of parliament for the Conservative party, but three years later he moved his support to the Liberal party. He married Clementine Hozier in 1908. As First Lord of the Admiralty in 1911 Churchill was one of the first to foresee the First World War, and made sure that the British navy was prepared.

After the war Churchill rejoined the Conservative party and became Chancellor of the Exchequer. Churchill became prime minister in 1940, the year after the Second World War began. His stirring wartime speeches made him the symbol of resistance to the Nazis when Britain became the only country to hold off Nazi attacks. In 1945 his party lost the general election, but Churchill became prime minister again in 1951. He was made a Knight of the Garter and retired as prime minister in 1955.

Cinema Going to see films, or 'movies', is one of our most popular forms of entertainment. We go to be thrilled by the gun-battles and saloon brawls in westerns, delighted by the singing and dancing in colourful musicals, amused by animated cartoons, and informed by documentaries and newsreels. These are among the most important kinds of films.

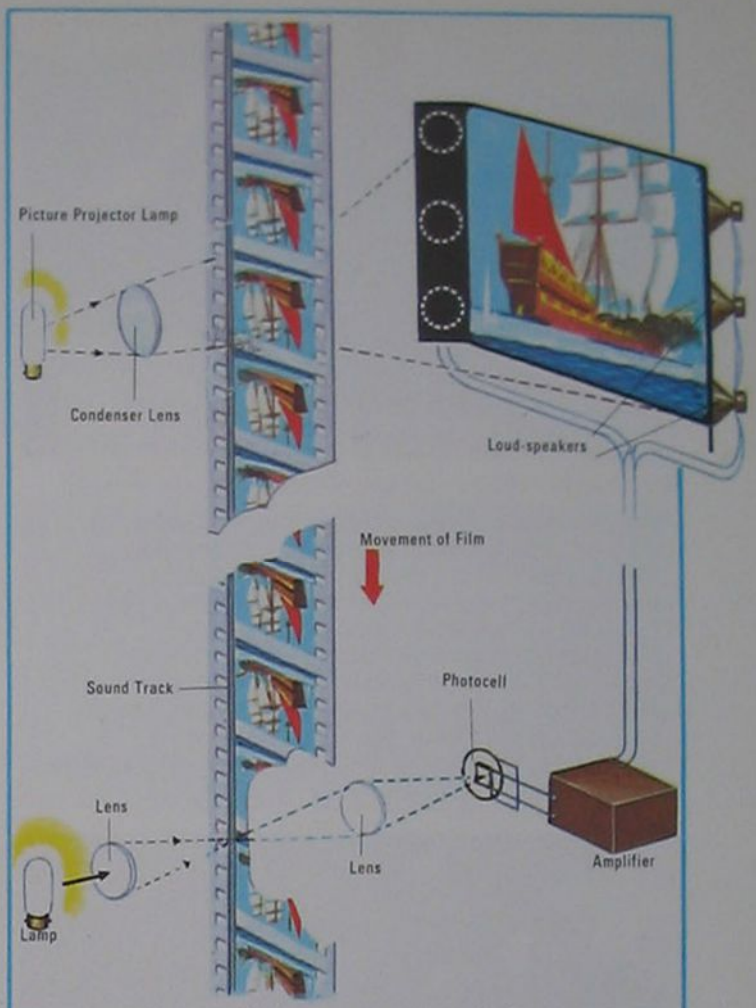
The most important man in commercial film-making is the producer, who supervises the whole project and selects the cast of actors and actresses to play in it. The director controls the actual filming of the scenes. The screen writer prepares the script from which the actors learn their lines. And there are hosts of designers, craftsmen and technicians.

The greater part of most films is taken, or *shot*, in a film studio. Realistic *sets*, or backgrounds, are built to resemble rooms, buildings and streets. Most of the sets are merely supported shells. Often scenes are taken on location outside the studio to heighten the realism. At the end of filming, the exposed film strip in the cameras is processed. The director and a film-editor then choose the scenes to include in the picture.

The cine camera works on the same principle as the still camera, but takes a series of still shots in quick succession. The film strip used is exactly the same as that used in still cameras. And it is *developed*, or processed in much the same way. (See Photography.)

The camera takes 24 separate shots, or *frames*, every second. A claw mechanism holds the film strip still while each frame is shot and then moves the next frame into position. A half disc shields the film while it is being moved to prevent blurring of the image.

The sound for the film is picked up by microphones suspended on long poles, or *booms*, above the actors but out of sight of the cameras. The microphone changes sound into a varying electric current. This current is converted into a varying pattern of light, which is recorded as a *sound track* on the edge of the film strip.

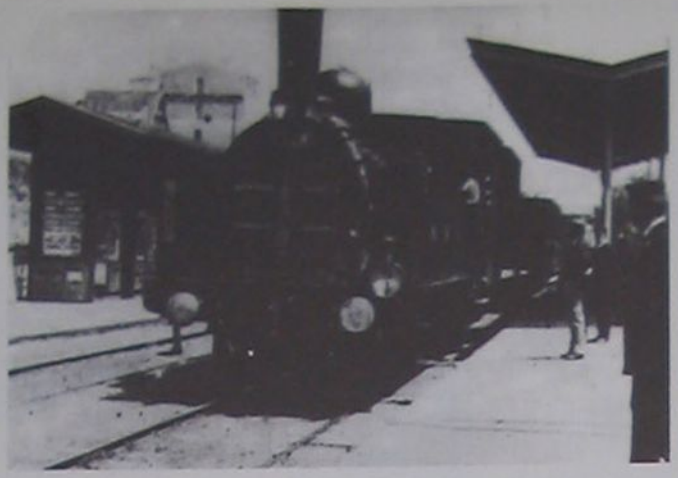


Light from the lamp passes through the sound track to the photocell, where a varying electric signal is produced as the film moves. The signal is amplified and fed to the loud-speakers.

When the film is completed, it can be shown through a *projector*. In the projector, a bright light from an electric-arc lamp shines through the film strip and throws a magnified image onto a white screen. It projects 24 frames every second—the same rate at which the camera took them. It has a device for blocking off the light while the film is actually moving from frame to frame.

This means, of course, that the screen is dark between frames. But we do not notice this because our eyes continue to see the previous frame. This is called persistence of vision. It enables us to see the separate frames as a continuous moving picture.

Light-sensitive cells in the projector convert the sound track back into sound,



The first public showings of cinema films were made in 1895 in France by the Lumière brothers. Above: This film of a train arriving at a station made people jump up to get out of the way. Below: Films were silent until 1927 and actors used exaggerated gestures and expressions to convey meaning. This scene is from *Way Down East* starring Mary Pickford. Bottom: Many films are made largely on specially built 'sets'. Here a scene is being 'shot'; hanging over the actors is a sound microphone.

Ancient Rome has provided stories for many great cinema 'epics'—spectacular historical films made at great cost and with thousands of actors.

which is relayed to loud-speakers behind the screen.

Early films, however, were silent. The first ones were made in 1895. But before then various people had invented devices which relied on the persistence of vision to give the illusion of movement. They included the *phenakistoscope* (1832), the *zoetrope* (1860), and the *kinetograph* (1868). In 1894, the American inventor Thomas Edison showed short films in a cabinet called a *kinetoscope*.

In 1895, films were first projected successfully, and the cinema had begun. To start with, they were shown in fairgrounds and as items in variety shows. But soon cinemas were built especially to show them. Films became known as the 'flicks' because of the flickering of the screen. This happened because they were projected at only 16 frames a second.

Talking points

*When television became popular, people said that the cinema would die. This has not happened. Say what you think the cinema still has to offer.

*Films are very expensive to make (the Russian version of War and Peace cost £40 million). Why do you think films cost so much?

*In many countries, children under a certain age are not allowed to see certain films. Do you agree with this form of censorship?

Articles to read

Camera; Cartoons; Charles Chaplin; Walt Disney; Photography.

Until 1927, films were silent. Pianists in the cinema provided background music to suit the action on the screen. Then, in 1927, Al Jolson starred in *The Jazz Singer*, the first sound film. From then on, the cinema developed rapidly. In the 1950's the wide-screen processes of Cinerama, Cinemascope and Todd-AO were introduced.

Circus is a Latin word meaning 'a ring'. The first circuses were U-shaped tracks used for chariot-racing by the Romans. Two- or four-horse chariots were driven seven times round the track by charioteers, who needed great skill and courage to turn the sharp bend at high speed. The sport was very popular and the Circus Maximus at Rome could hold about 250,000 spectators.

Circuses today are very different. The idea of riders, acrobats, jugglers, clowns, horses and wild animals performing in a ring watched by people began in the eighteenth century.

In 1768 Philip Astley set up a riding school on leaving the British army. He was a skilled rider and found he could make more money from displays of trick riding. Part of his act was to ride in a circle while standing on a horse's back. In this way the shape of the circus was fixed. Astley built an arena for his circus in London and later in other cities in Europe. The idea spread and John Ricketts opened a circus in Philadelphia in 1793.

Horse-riding and spectacular displays of famous battles were features of early circuses. Clowns also performed, and during the nineteenth century other acts were added. Van Amburgh, an American, said to be the first man to put his head in a lion's mouth, made wild animal acts popular. Acrobats and jugglers left fairs for circuses and the flying trapeze, in-

A circus parade in Milwaukee, U.S.A. In America, circuses often go on parade when they arrive in a town, to attract an audience for the show.

Above: A trapeze artist seems to fly through the air with the greatest of ease. But in fact it takes much skill and training to perform these daring feats.

vented in 1859, was used for deeds of daring.

Travelling circuses were made popular by 'Lord' George Sanger in Britain and by Barnum and Bailey in America. Travelling circuses paraded through a town before setting up the 'big top', the tent where the performance took place. Barnum and Bailey's 'Greatest Show on Earth' had five rings in its 'big top', which could hold 12.000 spectators.

Circuses are still popular today, but the costs of travel and animal upkeep have led to a decline in the numbers of travelling circuses.

The world's largest permanent circus is the Circus Las Vegas, Nevada, U.S.A. It was opened in 1968 at a cost of 15 million U.S. dollars. It covers an area of 129,000 square feet and has a 90-foot high tent-shaped flexiglass roof.

Opposite: The tiger tamer at a circus needs patience and understanding to train his animals. He also needs great courage; they will never be reliable.

Citrus Fruits include the orange, lemon, grapefruit, mandarin, tangerine, lime, kumquat, citron, and bergamot – all members of the genus *Citrus*. Citrus trees are small evergreens, originally found in South-East Asia. They bear fragrant flowers, which are followed by the fruits. These are berries, with tough, oily skins.

Citrus fruits are important agricultural products in Mediterranean countries, the southern United States (such as Florida), Mexico and South America. All citrus fruits contain citric acid, which has a sour taste like lemon juice. But in many citrus fruits, the sour taste of the acid is overcome by the sweetness of sugar in the fruit. Citrus fruits also contain ascorbic acid (vitamin C) and are im-

Oranges being harvested by men and machines in Florida, U.S.A.

portant health-giving foods. Flavouring oils can be made from the rinds.

Oranges, lemons and grapefruits are the best-known citrus fruits. They are eaten raw, and used for making flavourings and marmalades.

Mandarins and tangerines are small, orange-like fruits. Unlike oranges, they have a fragrant odour. Limes look like green lemons, and are grown for their juice rather than the fruit itself. On long voyages, sailing ships carried limes to prevent the crew getting scurvy, a condition caused by lack of vitamin C. Kumquats are very sweet fruits resembling small oranges. They may be eaten fresh or candied. Citrons are large sour fruits grown for their rinds, which are used to make oils for perfumes and flavourings. Bergamots are orange-like fruits also used to make perfumes.

City is a place where thousands or even millions of people live and work together. In cities, government buildings, banks, factories, offices, shops and markets exist side by side with houses and blocks of flats. Cities usually provide the largest proportion of a nation's wealth, because industry is concentrated in them. City land is very valuable, and, as a result, city buildings are usually high and crowded together.

People who live in cities can take advantage of a great variety of shops, restaurants, theatres, schools, museums and libraries. But not everyone who works in a city lives there. Many like to *commute* by train, car or bus from their homes in the *suburbs* (residential areas surrounding the city centre) or in the countryside.

City authorities have to face complicated problems in making their cities better places in which to live and work. Because so many cars, buses, trains, factories and houses are crowded together, cities tend to be noisy and dirty. A city has vast sanitation, water, electricity, gas and transport needs, and any breakdown in these essential services can quickly become disastrous. In poor areas, crowding and dilapidated housing make slums.

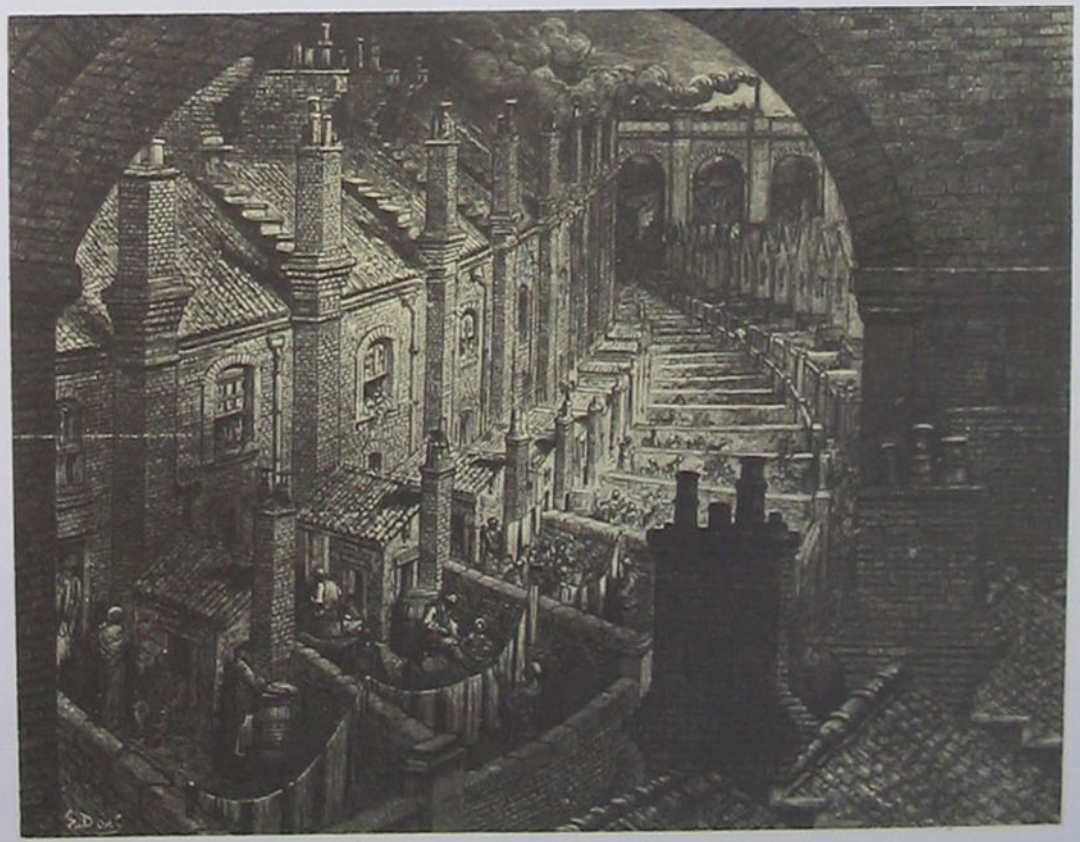
In ancient times, cities grew around a fortification, a port or a point where trade routes crossed. Many cities owe their modern character to the Industrial Revolution, when it became necessary to gather together supplies, workers, distributors and transport.

Civil Engineering is a branch of applied science that shapes the look of towns and cities and of much of the country. Civil engineers plan offices, factories and houses, roads and bridges, airports and railways, harbours and dams, tunnels, canals and sewers. They also supervise the building of these structures.

Civil engineers must have a great deal of specialized knowledge. They must learn the principles of building construction and in what ways the different kinds of building materials can best be used. And they must know just what materials are best in different climates and conditions, since civil engineers may travel all over the world. They must be able to survey sites and find out about the soil and rock. They must know how to use all the different kinds of building equipment, from bulldozers and shovels to cranes and pile drivers. And they must be able to see that teams of workmen can carry through all the stages of their plans. It is not surprising that civil engineers must study for many years to qualify.

Although civil engineering is a modern term, there have been great planners and builders for thousands of years who have in fact been civil engineers. They built astonishing things even by today's standards, although their equipment was relatively simple. In about 2600 B.C the ancient Egyptians built several pyramids that reached heights of nearly 500 feet The ancient Romans built huge amphitheatres and cities and houses with elaborate drainage and heating systems. They carried water to their towns by aqueducts

Above: The modern city centre in Coventry shows how careful planning and consideration for the needs of people can make a city a pleasant place in which to live.



Right: A row of houses built for workers in London in the 1800's illustrated by Gustave Doré. Overcrowded and insanitary conditions were breeding grounds for disease and produced a high death rate.

Modern earth-moving equipment makes the building of a new road through rough country far easier and far speedier. Before the invention of these machines a project of this nature would have needed a huge work force and might have taken years to complete. Civil engineers work together with local and central planners to find the best routes for new roads.

many miles long In the Middle Ages men built superb cathedrals which rivalled the pyramids in height Today modern techniques allow civil engineers to build huge skyscrapers, long suspension bridges and networks of roads crossing deserts and mountains.

The longest road in the world will be the Pan American highway, which will stretch from Alaska to southern Chile. The tallest man-made structure is the 2,063 feet T.V. transmitting tower at Fargo, North Dakota, U.S.A. The world's longest canal system is the Volga Baltic in the U.S.S.R. which has a length of 1,850 miles. The Hirakud Dam in India is the longest in the world and measures 15.8 miles across the Mahanadi river. The longest tunnel to carry traffic is the Simplon II railway tunnel—over twelve miles—which runs under the Alps between Switzerland and Italy.

Civilization is an advanced stage of human society. The word *civilization* comes from the Latin word *civis*, meaning *citizen*. As people develop from savagery to civilization, they begin to think of themselves as members of a nation or state, with a central government. They also build permanent cities, where many of the activities of their state are concentrated. Because they have learnt to write, they are able to pass on what they know to succeeding generations. The sciences and the arts begin to flourish.

Civilized people divide up the essential tasks of the community. Some members become farmers, others become bakers, lawyers, weavers and so on. Technology develops—that is, increasingly efficient tools and machines are invented. Life becomes physically more and more comfortable. Medical discoveries help people to fight disease.

The earliest civilizations developed independently in China, the Indus Valley of India, Egypt and Mesopotamia, thousands of years ago. At a later stage the more developed and complex civilizations of ancient Greece and Rome reached their heights. In the Americas, the Aztecs, Mayas and Incas founded great civilizations, of which little is left.

Civil service All governments need full-time servants. The rulers of a country need people who will advise them expertly and without prejudice but who will also obey orders. These are the civil servants. They are 'civil' in contrast to the armed forces.

A games table from the tomb of the ancient Egyptian pharaoh, Tutankhamen who lived in the 14th century B.C. The civilization of the Nile valley began over 4,000 years ago. This table shows the skill of the Egyptian craftsmen; it also tells us that a game similar to chess or draughts was played by the Egyptians.

As the task of government has grown more complex, the civil service has grown larger. Most civil servants are clerks and typists, responsible for the paperwork which modern administration produces. Too often the civil servant is the man for whom you have to fill in a form. But without these ordinary men and women the social services and the schools, for example, would not work. Governments may also employ many other types of civil servants, ranging from workmen in government factories to research scientists and economists.

Civil War, American (1861-65) This was a war fought between the Northern and Southern states of the USA. For many years before the Civil War, the Northern and Southern states had opposed each other. There were many differences between their ways of life. The South was mainly agricultural and relied on growing sugar and cotton. Cotton was grown on large farms called plantations, where most of the labourers were black slaves. In the North many people worked in factories making iron and cloth, and there were rich merchants and bankers. Such people had no need of slaves. The South had few or no factories and relied on the North for most manufactured goods.

Bitter arguments grew up between the North and South over the problems of slavery in the new territories. These new territories were created as people moved westwards into new lands. The South thought that slavery should be allowed in some of the new territories. Many Northerners did not want slavery to spread to the new territories and even wanted to abolish slavery in the South as well. In 1861 Abraham Lincoln, a Northerner, became President of the U.S.A. He belonged to the Republican Party, which had promised to pass laws to ban slavery in the new territories. Eleven Southern states therefore broke away from the Union, chose another President and called themselves the Confederate States of America. Abraham Lincoln had not intended to force the Southerners to free their slaves, but he could not allow them to break away from the Union. War broke out when Southerners captured Fort Sumter in

Above left: General Ulysses S. Grant. Above right: The Battle of Gettysburg (1863), in which the Confederacy suffered its first major defeat. Right: Flags of the opposing sides in the Civil War – the Union (top) and the Confederacy (bottom). Below: Abraham Lincoln, Union president, with troops at the Battle of Antietam (1862). Bottom: Confederate states (dark green) and Union states and territories (blue).

Charleston harbour, South Carolina in April 1861. For two years the South fought successfully. They were led by two brilliant generals, Robert E. Lee and 'Stonewall' Jackson. Lee won the South's first victory at the First Battle of Bull Run in July 1861. 'Stonewall' Jackson was killed after another Confederate victory at Chancellorsville, Virginia, in May 1863. Two months later, Robert E. Lee was defeated at Gettysburg. In this terrible battle, George E. Meade stopped Lee's invasion of Pennsylvania and drove him back towards Richmond, the Confederate capital.

A day after the Union victory at Gettysburg, a Union General, Ulysses S. Grant, captured the city of Vicksburg in Mississippi after a long siege. Lincoln made him commander of the Union armies. Grant's victory at Vicksburg had given the Union armies control of the Mississippi River. They had captured New Orleans in 1862, and their control of the river cut the Southern states in two. Meanwhile, General Sherman led a northern army into Georgia and South Carolina to cut the South into two from east to west. The army seized or destroyed food, cattle, horses and factories and left behind burning houses and fields. In 1865 Grant captured Richmond and on 9th April Lee surrendered, thus ending the war.

Over 200,000 men died in battle. The South lost because it had fewer men and also because, unlike the North, it lacked the factories for making guns and other war supplies. The Southern states could

Wounded Union soldiers resting after the Battle of Fredericksburg (1862). New weapons wreaked dreadful slaughter in the American Civil War and over 200,000 men were killed. It was the first war to be extensively photographed, and many pictures survive to show us the unpleasant conditions under which the soldiers fought.

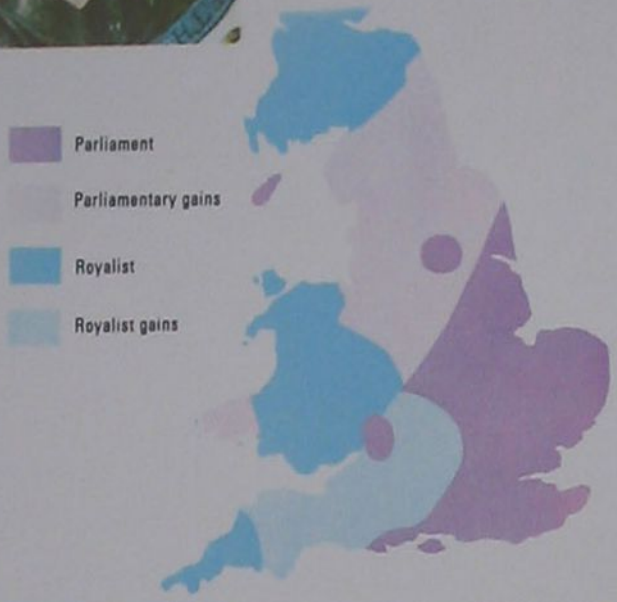
not get supplies from abroad because Northern ships blocked their ports. The Southern states again became part of the U.S.A. and all slaves were freed. But the Southerners felt bitterness towards their conquerors for many years to come.

Civil War, English King Charles I of England ruled the country without a Parliament from 1629 to 1640. When Parliament met in 1640 it attacked the King's chief ministers and introduced laws to limit the King's power. The King had to agree at first. But the House of Commons tried to cut down his powers even more; so, in January 1642, Charles tried to arrest the five M.P.s who chiefly opposed him. He failed. The Parliamentary leaders prepared to fight against the King while Charles left London to raise armies to defeat Parliament.

On both sides, country gentlemen came with horses and servants to join the armies which were formed. Other soldiers were taken from the militia, men who had to do some training each year and who were armed with muskets or with pikes. Parliament controlled the navy and the chief ports, so King Charles got little help from abroad.

The first part of the Civil War lasted from 1642 to 1646. At first the King was successful. In 1642 a Parliamentary army was defeated at Edgehill in Warwickshire, and the King's dashing nephew, Prince Rupert, nearly reached London. Parliamentary forces held out in several parts of the country and prevented the success of the King's plan to send three Royalist armies to surround and capture London in 1643. Parliamentary forces led by Oliver Cromwell held the East of England. In 1643 the Scots entered the war on Parliament's side and in 1644 joined with Parliamentary armies in defeating the Royalists at Marston Moor near York. The King lost the North of England.

Left: Oliver Cromwell, the leader of the parliamentary forces. He always insisted that painters should not flatter him in their portraits. Below: A map showing the areas held and gained by the two sides during the English Civil War.



In 1645 Parliament set up the 'New Model' Army under Thomas Fairfax and Oliver Cromwell. This was well-equipped and well-trained. It was the first English army to have a uniform—the red coat. It defeated the King's forces at Naseby, and in 1646 the King surrendered.

In 1648 war began again when the Scots invaded England in support of King Charles. Cromwell and the New Model Army beat them at Preston. Other Royalist forces were put down. After this the King was tried and executed.

Clams and oysters are two kinds of edible *molluscs*. These are invertebrate animals which are protected by one or two shells, or by having a kind of shell inside their bodies. (See Molluscs.) Clams and oysters, which have two shells hinged together at one end, are called *bivalve* molluscs.

Oysters and most clams live in the sea. They feed on the tiny water plants and

The Giant Clam is one of the largest living bivalves. It is found notably on the Great Barrier Reef off Queensland, Australia. The valves are oval and can measure more than 4 feet long and 3 feet wide. A careless bather who steps into a gaping shell may suffer a severe injury when the valve snaps shut.

animals called *plankton*. A clam has a fleshy organ or *foot* which sticks out of the shell. With it the clam burrows into mud or sand. An oyster, which has no such foot, attaches itself to the sea bed by cementing one shell to a rock.

Oysters and clams are both popular foods, and in some countries oysters are reared on special 'farms' in coastal waters. Both clams and oysters are often eaten raw, but clams are also made into the thick soup called clam chowder and may be eaten fried, while smoked oysters are a delicacy.

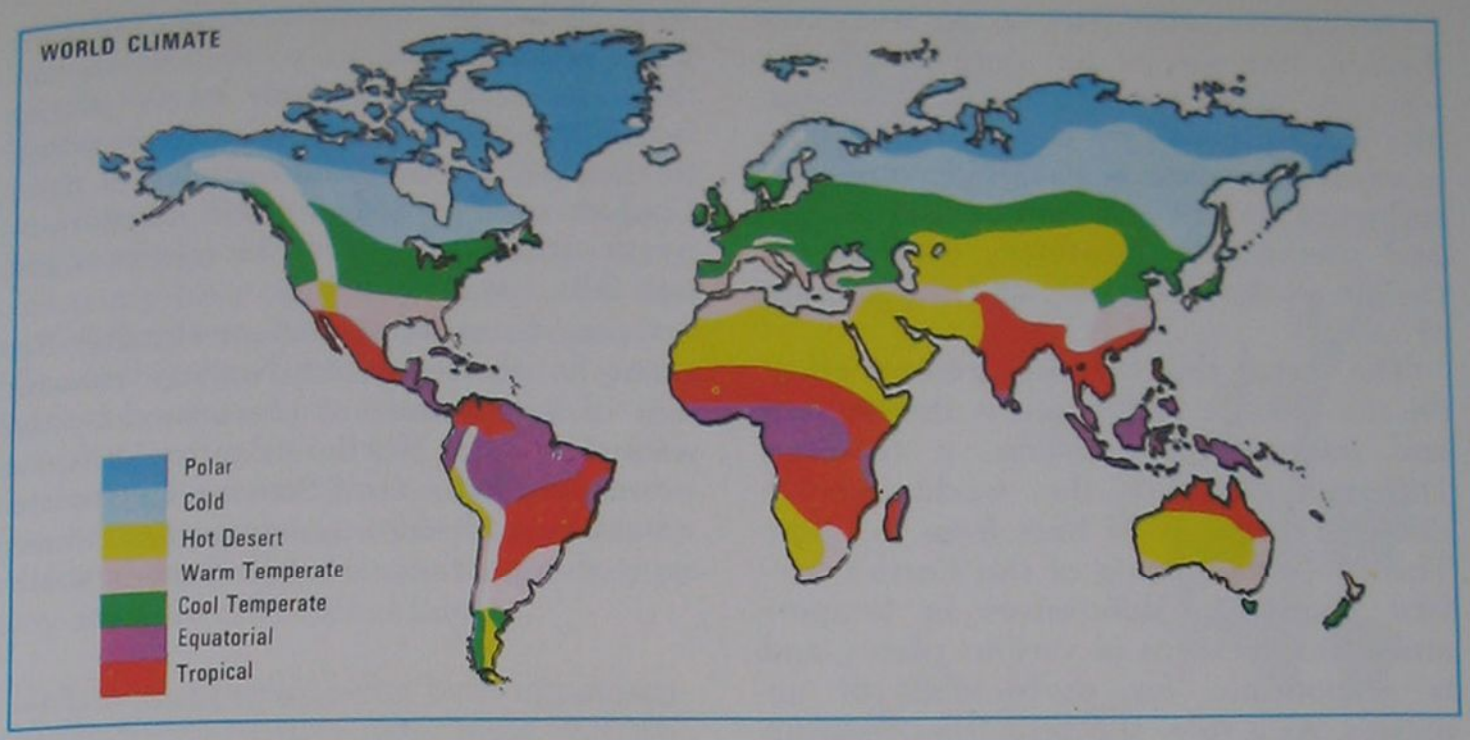
Clackmannanshire, the smallest county in the British Isles, borders the Firth of Forth in Scotland. Its county town is Clackmannan, and its area is 55 square miles.

In the south, coal is mined in the Devon valley. Sheep are reared in the Ochil Hills in the north. There is also some brewing and distilling. Alloa is the administrative centre for the county.

Cleopatra (69-30 B.C.) was Queen of Egypt. Two great Roman leaders fell in love with her, and her story has inspired plays such as William Shakespeare's *Antony and Cleopatra* and George Bernard Shaw's *Caesar and Cleopatra*.

Cleopatra was 17 when her father the Pharaoh (king) of Egypt died, leaving her and her 10-year-old brother to rule together over his kingdom. Her brother's guardians seized power and drove her from the throne.

Soon afterwards, Julius Caesar, ruler of Rome, went to Egypt. Cleopatra was brought to him secretly and he fell in love with her. With his help, she organized a revolt against her brother. She then went to Rome with Caesar. But she returned to Egypt when he was assassinated.



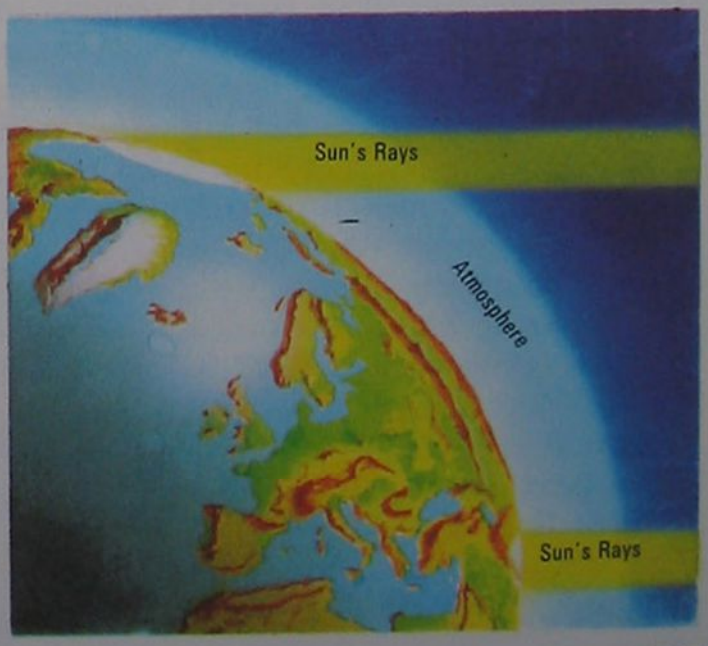
Two years later, Mark Antony, a follower of Caesar's, came to visit her. He, too, fell in love with her. Although he was one of the three men who ruled Rome, he decided to remain in Egypt. Octavian, another of the three, grew angry and determined to destroy the lovers.

A great sea battle took place near Actium on the west coast of Greece. Octavian won, and Antony and Cleopatra were forced to retreat to Alexandria, the capital of Egypt. Octavian's forces surrounded the city.

Knowing she was defeated, Cleopatra lay in the tomb built for her burial, and sent word to Antony that she had killed herself. Thinking her dead, he ran himself through with his sword. According to legend, Cleopatra killed herself by allowing herself to be bitten by an asp, a poisonous snake.

Climate A region's climate is its general pattern of weather over a long period of time. The weather in a region may, at some times of the year, change almost from day to day. But the climate remains similar year after year. For example, a seaside town in southern Italy may have a week of hot, dry days, followed by a dull, warm day, and then a cold, wet day. But these rapid weather changes do not affect the general climate of the place. Southern Italy has a 'warm temperate' climate, which means that in general it has hot, dry summers and mild, wet winters.

The main factor affecting the climate of any part of the world is its latitude. The further an area is away from the Equator to the north or to the south, the less the amount of heat it receives from the Sun. This is because the Sun's rays strike the Earth at an angle that increases with distance from the Equator, and the same amount of radiation is spread over a greater area of the Earth's surface. At the Poles, the radiation received from the Sun is so weak that there is permanent snow and ice. At the Equator, the Sun is high in the sky and the climate is hot.



No matter what part of the world we live in, our way of life depends on the climate. How we dress, what we eat, the kind of house we live in—all may be governed by climate. Factors having most influence on climate include the amount and intensity of sunshine, the *altitude* (height above sea level), and the amount of rainfall.

The factor that has the greatest effect on the climate of a place is the amount and intensity of sunshine it receives. Different parts of the world receive different amounts of heat from the Sun. This unequal heating of the Earth's surface results in differences in temperature and pressure in various places, and is responsible for movements of air masses. As a rule, the heat from the Sun is greatest at the Equator and decreases towards the Poles. This is due to the curvature of the Earth which makes a similar amount of the Sun's rays spread over a greater area near the Poles than near the Equator.

The Earth can be divided, broadly, into a number of temperature zones: hot (equatorial and tropical), warm temperate, cool temperate, cold, and polar. But these are not tidy zones stretching from the Equator to the Poles. They are made 'untidy' by, for instance, the effect of the oceans. Water heats up less rapidly than land, but keeps its warmth longer. Thus the oceans cool coastal regions of the continents in summer and warm them in winter. In contrast, regions far from the sea tend to have hot summers and cold winters. In parts of Siberia, far inland, the annual temperature range is more than 55° C. (about 100° F.).

Altitude affects climate because the air is thinner at higher altitudes. The temperature drops about ½° C. (about 1° F.) for each 300 feet up. Mount Chimborazo, in Ecuador, straddles the Equator, but it has a permanent cap of snow.

Rainfall is a major feature of climate. The wettest regions are generally those reached by winds that have blown for long distances across seas and oceans. Hilly regions tend to receive more rain than lowlands, particularly on the slopes facing the winds. Mountains force winds to rise, and air becomes cooler as it rises. Cool air cannot hold as much moisture as warm air, and as a result clouds form and rain falls.

Ocean currents also affect climate. For example, the coast of Norway remains free of ice because it is warmed by the waters of the North Atlantic Drift, an extension of the Gulf Stream. But coastal waters in Labrador are frozen in winter even though they are 15° farther south.

Talking points

*Why is the climate warmer at the Equator than it is in the polar regions?

*Take the air temperature at the same time every day for a year. Plot the results on a graph and see how the temperature changes through the year.

*There are three different sorts of rainfall. Find out what they are and try to learn which type normally falls in your area.

Articles to read

Air; Atmosphere; Barometer; Condensation; Equator; Equinox; Fog; Frost; Hail; Meteorology; Rain; Snow; Thermometers; Wind.

Climbing plants make up a large, unrelated group of plants that are adapted in various ways for climbing up supports or other plants to reach the light. Some plants, such as goosegrass or cleavers, have curved outgrowths that point downwards and serve as a means of scrambling up other vegetation. Ivy stems bear roots which give out a sticky fluid and glue the plant to its support.

Many plants have thread-like outgrowths called *tendrils*, which are usually modifications of leaves or parts of leaves. The tendrils twine round anything they touch, giving the plant support. The reduction in leaf area due to tendrils in leguminous plants such as vetches and sweet peas is balanced by the development of leafy outgrowths called *stipules* at the base of the leaf stalk. Hence, the food-making capacity of the plant is not reduced.

A third group of climbers achieve their aim by winding their stems round the

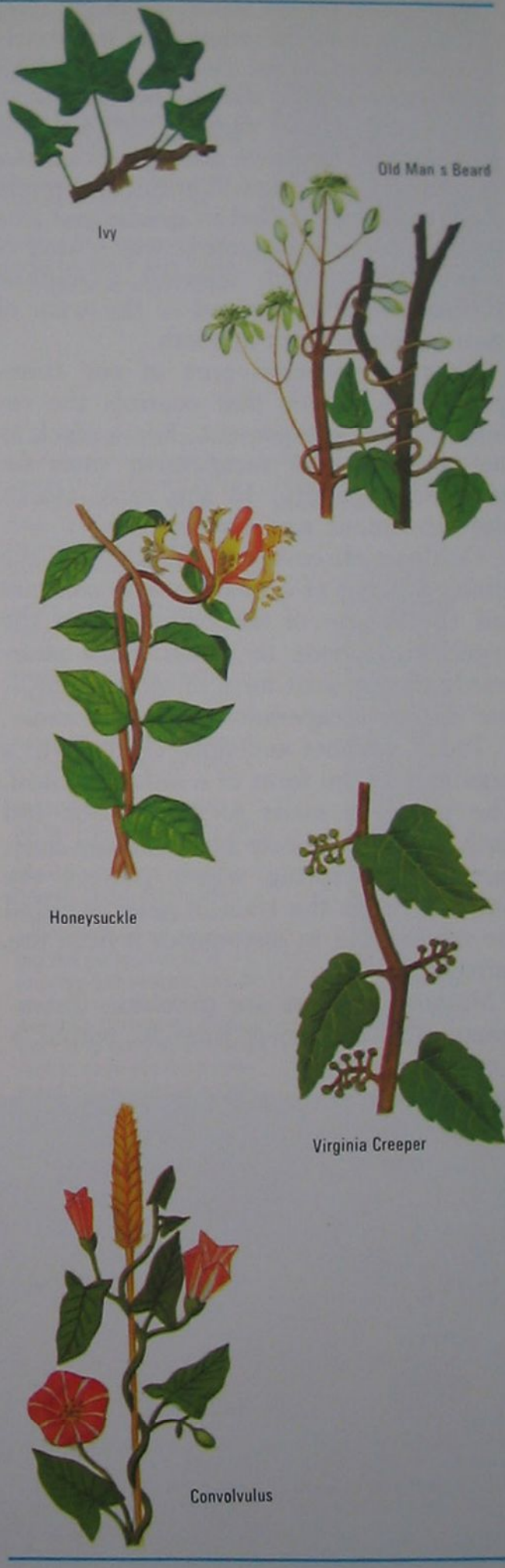
stems of other plants. Bindweed and honeysuckle are two common examples of twining plants, but there is a major difference between them: bindweed twines in an anticlockwise direction (looked at from above the plant), whereas honeysuckle twines clockwise. Twining plants commonly bear only tiny leaves near the top of the stem, and these are separated from each other by long sections of stem. Such an arrangement means that the stem can twine round the support before the leaves become large enough to interfere. Twining plants are particularly common in tropical rain forests where they are generally called *lianas*.

Clocks and watches Long before mechanical clocks were invented, Man had discovered means of measuring the passage of time. The position of the Sun told early Man what time of the day it was. Then he noticed how the shadow of a tree or a stick moved round in a semi-circle during the day. From this he devised the *sundial*.

The ancient Egyptians invented *water clocks* about 4,000 years ago. In the simplest of these, the position of the water level in a leaking vessel indicated the time. *Sand glasses*, just like the ones we use as egg-timers, were also in widespread use in ancient times.

Mechanical clocks were not developed until at least the A.D. 1200's. They evolved from *astronomical clocks* used by astronomers to demonstrate the movements of the heavenly bodies. The early clocks were driven by *weights*. A rope carrying the weight was wound round a drum. As the weight descended, the drum turned and moved a mechanism which struck a bell at regular intervals. Dials and a moving hand to indicate the time did not appear until the 1400's.

At about the same time, someone invented the *coil spring* as an alternative to the weight for driving a clock. This meant that clocks could be much smaller. Peter Henlein produced his famous



Nuremburg pocket clocks in about 1500. These were the forerunners of the watch.

In all mechanical clocks, some device is needed which allows the system, or *train*, of gear wheels driving the mechanism to move slowly. Otherwise the weight or spring will uncoil in seconds. Such a device is called an *escapement*. The earliest *verge* escapement was a kind of rocking bar which allowed a toothed *escape wheel* at the end of the train of gears to move tooth by tooth.

Another essential part of any timepiece is a device that controls the release of the escapement. For a clock to be accurate, the escapement must be released regularly. In the early clocks, the movement was not regular.

Galileo's discovery in 1581 that the time of swing of a *pendulum* is constant led to the use of the pendulum as the regulating device in clocks. Soon afterwards the present form of escapement—the *anchor* escapement—was invented.

Today, watches and small clocks have a regulator in the form of a *balance wheel*. The wheel is made to swing back and forth at a steady rate by a delicate *hairspring*. The spring which powers the watch through the train of gears is called the *mainspring* to distinguish it from the hairspring.

Modern watches are precision instruments that can keep time to within a matter of seconds each day. They have jewelled bearings (usually artificial rubies) for the moving parts, which last indefinitely without wearing out. Some watches wind themselves up automatically.

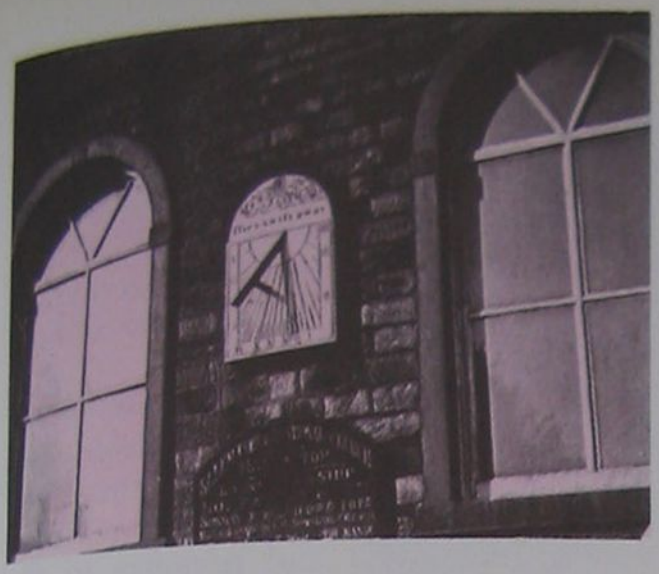
One of the most accurate modern clocks is regulated by the vibrations in a quartz crystal. Some electric clocks are regulated as well as driven by the electricity supply.

The most accurate clocks are atomic clocks. These clocks depend on the vibration of atoms to regulate them. They are used by scientists who measure time extremely accurately.

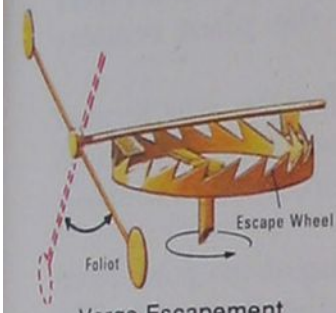
Clouds are masses of water droplets or ice crystals suspended in the air. When air rises, it expands and cools. Cool air cannot hold as much water vapour as warm air. Eventually the rising air cools to a temperature at which it can no longer hold all of its moisture in the form of vapour. The extra water vapour is deposited on small particles that are always to be found floating in the air—salt crystals, pollen, dust, etc.—and it forms the water droplets or ice crystals that make up a cloud.

Clouds have two distinct forms. *Cumuliform* (heap) clouds usually have a fairly level base with fluffy upper parts. *Stratiform* (layer) clouds usually appear in an even, unbroken blanket across the sky.

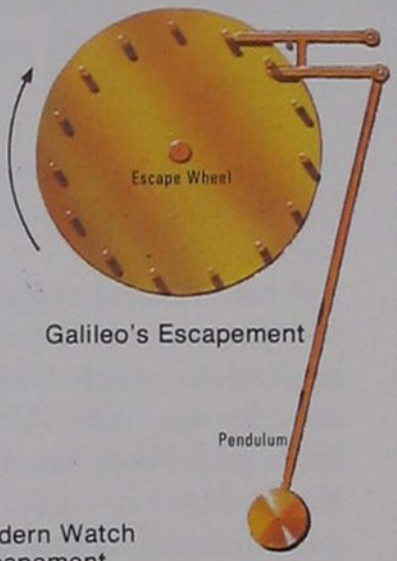
The different types of clouds are known by Latin names which describe their shape and height. These names are given in the table on page 299.



Left: The sundial is entirely dependant on sunlight to show the time, and was one of the earliest forms of clock. Right: Mechanical clocks came into use in Europe in the 1200s, and were first driven by weights. Coiled springs came to be used instead of weights, and time pieces could be made much smaller. This beautiful watch was made in England in about 1630.



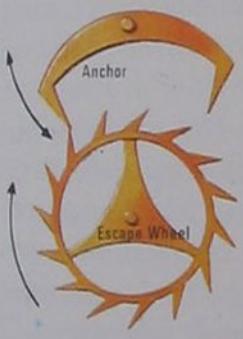
Verge Escapement



Galileo's Escapement

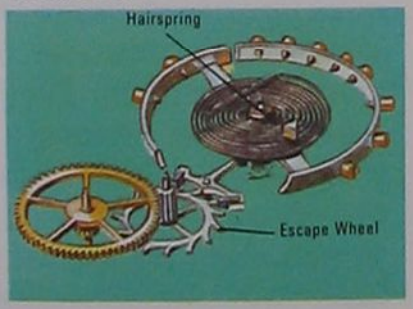
In all clocks, some device is needed to regulate the power of the driving force so that the clock keeps time. This device is called an escapement. The earliest escapement was the *verge escapement*, in which a rocking bar or *foliot* allowed a toothed escape wheel to move steadily tooth by tooth. The escape wheel is connected by gears to the hands. Galileo's discovery of the pendulum in 1581 led to the use of an escapement containing a pendulum. The rocking of the pendulum allows the escape wheel to move in regular jerks. Soon afterwards, this escapement was improved by connecting the pendulum to a rocking bar shaped like an anchor. In a modern watch, a hairspring swings back and forth at a steady rate to regulate the movement of the escape wheel.

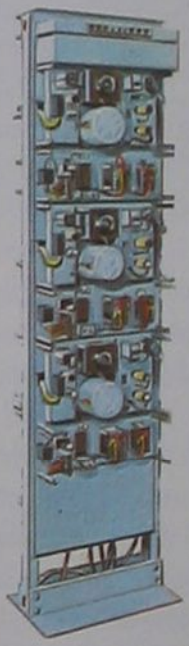
In the quartz crystal clock, vibrations in the crystal regulate the clock with great accuracy.



Anchor Escapement

Modern Watch Escapement



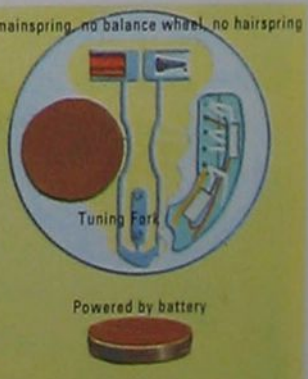


Quartz Crystal Clock

Ordinary Watches have to be wound up once a day to give them energy, which is stored in the mainspring.

Self-Winding Watches have a rotor that swings as the wrist moves and keeps the mainspring constantly wound.

Electric Watches contain a small battery that provides power to drive the watch, replacing the mainspring.



Electronic Watches contain a battery to drive a tuning fork that vibrates at a constant rate to regulate them.

CLOUD TYPES

Cirrus: Delicate, white, detached, high clouds, with fibre-like appearance. Its many forms include 'mare's-tails'.
Cirrocumulus: Thin sheet or patch of high cloud in the form of ripples or rounded small masses, often merged together. Sometimes produces a 'mackerel sky'.
Cirrostratus: Transparent film of fibre-like, whitish, high cloud. Frequently seen before a depression. It is generally the cause of a halo seen round the Sun or Moon (effects of ice crystals on light).
Altocumulus: Greyish-white sheet or patch of medium-high cloud, with shading, made up of rounded heaps, often merged together.
Altostratus: Greyish sheet of medium-high cloud, either fibre-like or uniform. Often produces the 'watery' sky seen before depressions.
Stratocumulus: Greyish-white sheet of low cloud, with shading, made up of rounded masses, often merged together.
Stratus: Uniform, grey, low cloud layer, similar to fog. May envelop high ground.
Nimbostratus: Grey, often dark, layer of cloud, sometimes blurred by falling rain or snow.
Cumulus: Detached, low cloud heaps, developing upwards; brilliant white when lit by Sun.
Cumulonimbus: The thunder-cloud. Dense, with upper portion usually flattened out in shape of anvil; its low base may be very dark.

Cloud forms are important in weather forecasting. The ten main cloud types are described in the table.

Coal is valuable not only as a fuel but also as a raw material for industry. We burn it on the fire to give us heat. Power stations burn it to produce electricity. Gasworks convert it to coke and gas.

Manufacturers also produce a wide variety of chemicals from coal, including drugs, plastics and dyes. But petroleum is rapidly replacing coal as a raw material for the chemical industry.

Coal measures are produced where coastal swamps once existed. As the sea moved in over the land and receded, various layers of rock formed between the coal measures.

Coal is often called a *fossil fuel* because it was formed about 250 million years ago during a period of prehistory called the Carboniferous Period. At this time, the Earth was covered with swamps and gigantic plants. Ferns grew as high as trees do today.

When the plants died, they fell to the bottom of the swamps and decayed. Deposits of mud formed over them. More plants grew and decayed and were buried under mud. Heat and pressure in the Earth's crust gradually changed the layers of mud into rock and the plant remains into coal seams.

Soft brown coal, or *lignite*, was formed first. Then this changed into dull, black *bituminous* coal, and finally into shining *anthracite*.

Coal mining—digging the coal from the ground—is a very big industry. The countries which produce the most coal are Russia, the United States, China, East and West Germany, and Britain, in that order.

Some coal is mined on the surface, but most is mined deep underground. Both forms of mining are now highly mechanized. (See Mining.) On or near the surface, coal is mined by the opencast method. Huge power shovels first strip off the earth *overburden* above the coal seam. Then the coal is broken up by explosives and shovelled into trucks.

Underground mining is more complicated, more expensive, and more dangerous. Shafts are sunk down in the ground, and tunnels are struck outwards from the shafts to the coal seams. In most mines coal *winning*—hewing it from the coal face—is done by machinery.

One machine, called a *continuous miner*, rips coal from the face and loads it onto a conveyor belt. In another method, miners cut a slice near the base of the face and bring down the coal with explosives.

A great many precautions have to be

Some coal measures occur at the surface and can be dug from quarries instead of mines. In Australia, coal measures are stripped from the surface at Moura mine in Queensland.

taken to prevent accidents in the mines They are well ventilated to prevent suffocating and explosive gases collecting. They are constantly drained to prevent flooding. The tunnels are *shored up*, or supported, with steel and concrete.

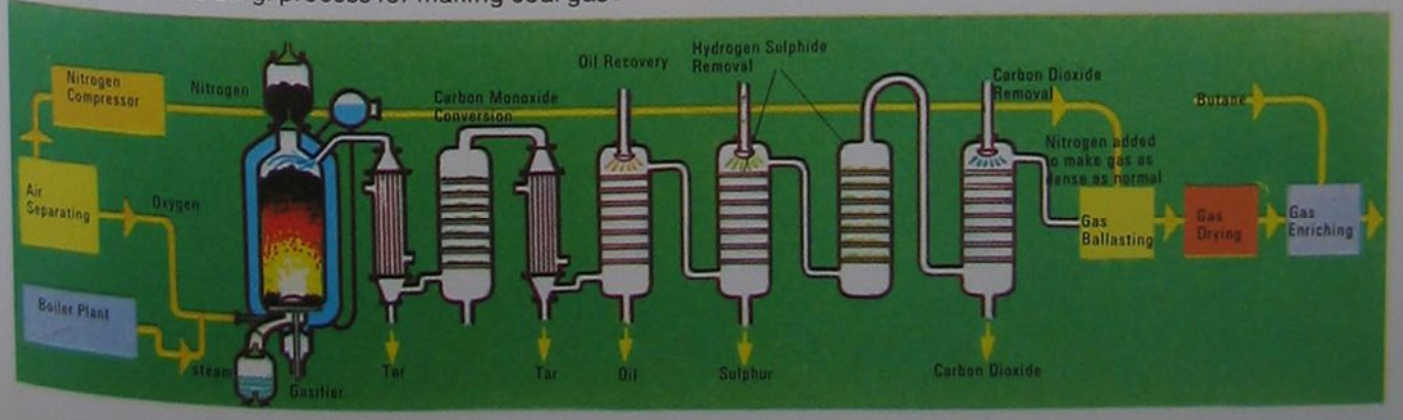
Much of the coal mined goes to be burned in power stations or in the home. But an enormous amount is made into coke and gas by *carbonization*—heating without air. (See Coal gas.) This process also yields coal-tar, benzole, ammonia, and other gases. From these raw materials can be made perfumes, insecticides, drugs, dyes, plastics, saccharin, fertilizers, resins, creosote and tar.

Coal gas The gas we use in our houses for heating and cooking may consist of gas manufactured from coal, natural gas, or a mixture of both. (See Natural gas.) It may contain gas made from oil, too.

There are several methods of manufacturing gas from coal. True coal gas, or *coke-oven* gas, is made by heating coal in an airtight oven. In this process, called *carbonization,* the coal changes into coke and gives off gas, together with ammonia, tar, and other impurities.

The coke produced in the ovens is used to make another kind of gas, called *water gas,* or *blue gas*. This is made by passing *superheated* (very hot) steam

Flow diagram of the Lurgi process for making coal gas.



over white-hot coke. *Carburetted water gas* is blue gas which has been enriched by gases obtained by *cracking*, or breaking down oil by heating.

A further way of making gas from coal is called the Lurgi process. In this method, low-grade coal is heated very slowly under pressure. A mixture of steam and oxygen passing through the hot coal converts it into gas.

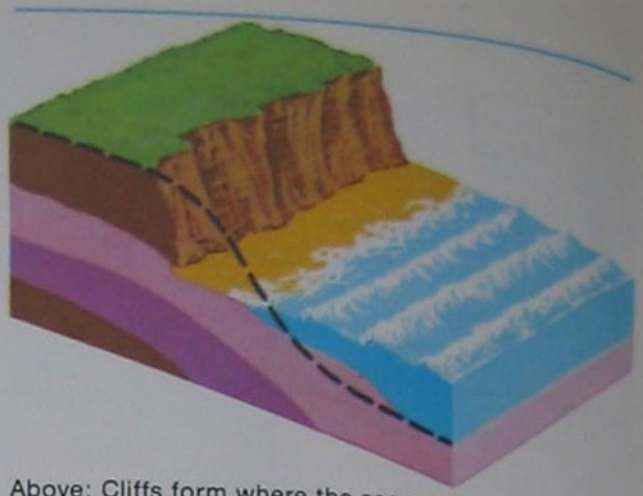
Each manufactured gas contains several inflammable gases. Coke-oven gas contains hydrogen, methane and carbon monoxide. Water gas contains only carbon monoxide and hydrogen. Oil gas enriches water gas by adding methane and other hydrocarbons which have a high heat value. The Lurgi process also produces hydrocarbons.

Coastguards are members of a government service which patrols the coast to aid shipping and to help anyone in danger from the sea. Their main job is to spot ships in distress and to help with life-saving. But they also *salvage* (recover) sunken goods, deal with off-shore oil pollution and inspect ships for seaworthiness. They provide weather information for shipping, and give warning of hazards. The coastguards were originally formed to catch smugglers, and in some countries they still perform this and other law enforcement duties.

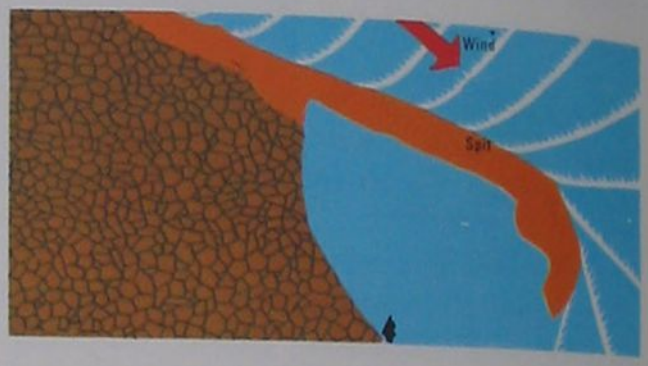
Coastguards have posts or stations at various points along the coast. Some stations, in areas where shipping is heavy, are manned permanently. Others are manned only in bad weather. To enable them to carry out their duties, coastguards use many kinds of boats, including fast motorboats, lifeboats, icebreakers and tugs. They also use aeroplanes and helicopters.

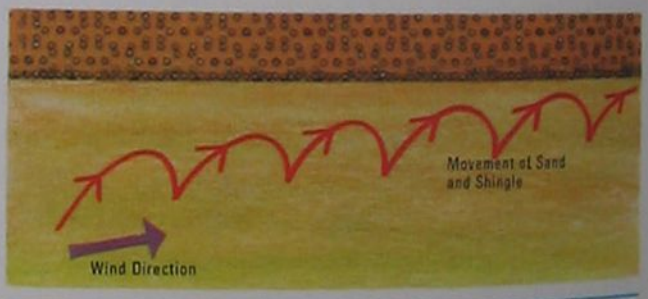
Coasts When you sit on a beach, you can watch the waves crashing against the shore. After each wave, the water runs quickly back down the slope. The swirling water is seldom clear, because it is carrying and moving fine grains of sand. The sea also moves pebbles. If you stand in the sea, you can often feel the pebbles move under your feet. In bad storms, huge waves can shift great boulders. The sea hurls large rocks and pebbles at cliffs, battering them and dislodging big chunks of rock, which crash into the sea.

Beaches and coasts are always changing. *Coastal erosion* occurs when the sea is wearing away the land. *Coastal deposition*



Above: Cliffs form where the sea erodes away land that slopes down into the sea. The action of the sea undermines the land, causing it to fall away and form vertical cliffs.





Longshore drift occurs where a current flows parallel to the shore. Above: As the current continues in a line where the coast turns inward at a bay or estuary, it carries sand and shingle with it, building up a spit across the bay or mouth of the estuary. Below: Another effect carrying sand and shingle along the coast is that of surf and the backwash of waves. These produce a zigzag movement in the direction of the prevailing winds.

occurs when the sea piles up sand and pebbles to form new land.

In some places, where the rocks are hard, coastal erosion may be very slow. But in Holderness, in Yorkshire, England, the sea is eroding the coast at an average rate of six or seven feet each year. Since Roman times, a strip of land about 2½ miles wide has been eroded by the sea.

Waves often erode caves in cliff faces. Sometimes the sea cuts caves into both sides of a headland and the caves meet to form a natural arch. If the arch collapses, a tall pillar of rock, called a *stack*, stands isolated from the coast.

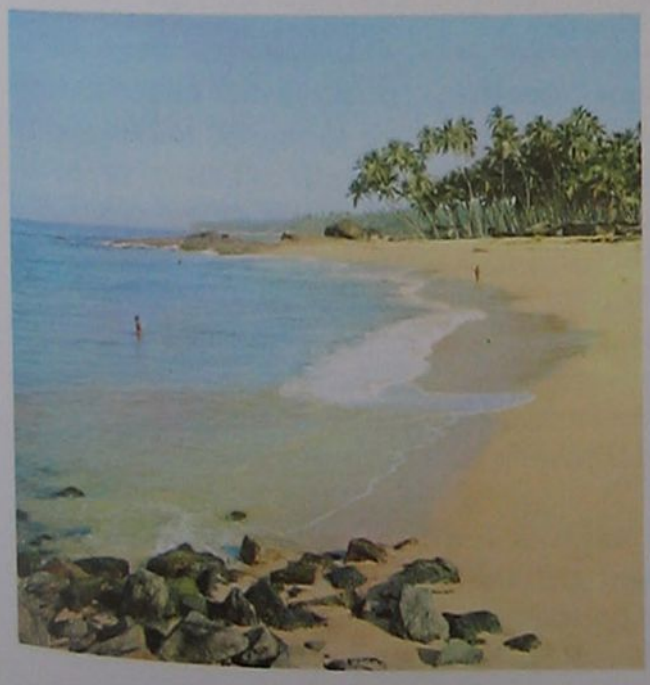
Some of the material worn from cliffs is swept out to sea. Some is moved along the coast and deposited to form new beaches and land areas. Sand, gravel and pebbles are sometimes piled up offshore to form long, narrow ridges called *spits*.

Coasts are also affected by rises and falls in the levels of the land and sea. If the sea-level falls, then rocky areas once under the sea are permanently exposed. Coasts of this type are called *coasts of emergence*. If the sea-level rises, the sea floods coastal areas. Such coasts are called *coasts of submergence*. The fiords of Scandinavia were valleys once occupied by great glaciers. After the ice melted, the sea-level rose, flooding the valleys and forming deep, long and narrow sea inlets.

Cocoa is a brown-red powder made from the beans of the cacao tree. The sweet, hot drink called cocoa is made by adding hot water, milk and sugar to cocoa powder.

The cacao tree is an evergreen tree that came originally from the Amazonian forests. It is now grown throughout the tropical regions of the world. It grows

Three kinds of shore. Above: Cliffs form where chalk hills meet the sea. The chalk cliffs around Dover are one end of the South Downs. Below left: Sandy beaches may form where the sea bed is almost flat. Many sand beaches occur in the tropics, fringed by palm trees and bathed in clear, warm water. Below: Where the shore contains hard rock, strange formations such as arches and stacks form.



Cocoa pods contain 40 or so purplish beans.

to a height of about 25 feet, and bears yellow egg-shaped fruits about a foot long. The fruit pods contain the beans.

Workers harvest the pods and scoop out the flesh and the beans. The beans are then allowed to ferment and dry. They contain a fatty substance called *cocoa butter*. When they are roasted and ground into powder, a thick liquid called *chocolate liquor* results. Chocolate is made by cooling and solidifying the liquor and adding other ingredients such as milk solids and sugar. Cocoa powder is made by forcing the cocoa butter out of the chocolate liquor in a press, leaving behind a solid mass of cocoa powder.

Codes and ciphers are ways of sending information secretly, most often used in wartime. Messages are coded so as to appear unintelligible if they fall into the hands of the enemy.

In many coded messages, the letters are replaced by other letters according to a definite plan or *key*. For example, a simple code would be to substitute B for A, C for B, and so on down the alphabet until we come to A for Z. The coded message is often broken up into groups of five letters, so that a message reading TFOEI FMQJN NFEJB UFMZ would mean SEND HELP IMMEDIATELY. A *cryptoanalyst*, a person who breaks codes, would have little trouble with this code. But many such codes have very complex keys. As well as substituting letters, the order of the letters can be rearranged in many ways.

Cryptoanalysts can break codes because they know that some letters occur more often than others. In English, the letters E, T, A, and O are the commonest letters. In addition, they would expect words such as ATTACK or TROOPS to occur frequently in certain messages.

Instead of using letters, a coded message might consist of a series of numbers. The key to the code might be the page of a book, the numbers giving a certain line down the page and the number of a letter in that line. For example, a code based on the first line of this article 'CODES AND CIPHERS ARE WAYS OF SENDING' could have numbers to represent the letters in the line – 1 being C, 2 O, 3 D, and so on. Thus the message 5 4 7 8 1 6 14 19 13 3 27 18 15 28 16 21 would mean SEND CAR WEDNESDAY. These codes are virtually impossible to break because a letter can be represented by more than one number – E in the above message is 4, 13, or 18.

The coelacanth is a 'living fossil' which lives at great depths in the sea. It is a lobe finned fish and scientists believe that the first amphibian that crawled out of the sea on to dry land 300 million years ago developed from this type.

Coelacanth is a kind of fish that has survived for more than 300 million years. Scientists had found remains of coelacanths embedded in rocks, and calculated that the fish must have died out about 60 million years ago. But in 1938 a specimen was found off South Africa and since then several live fish have been caught. The coelacanth is about 5 feet long, with a deep body and limb-like fins.

Coffee is a drink made from the roasted and ground beans of the coffee plant. It is a popular drink in many parts of the world. Many people find that coffee helps to

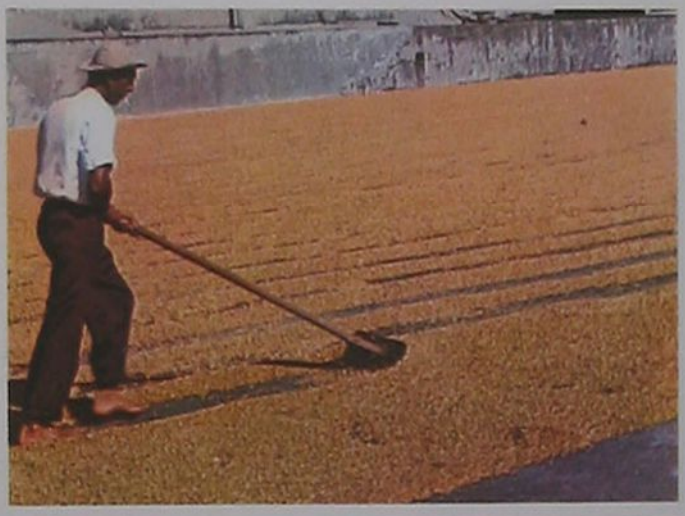
The Swedes are the world's greatest coffee drinkers. In 1969 29.27 pounds per person was consumed. The figure for the United Kingdom was 3.5 pounds per person.

keep them fresh and alert. This is because coffee contains a mild stimulant called *caffeine*.

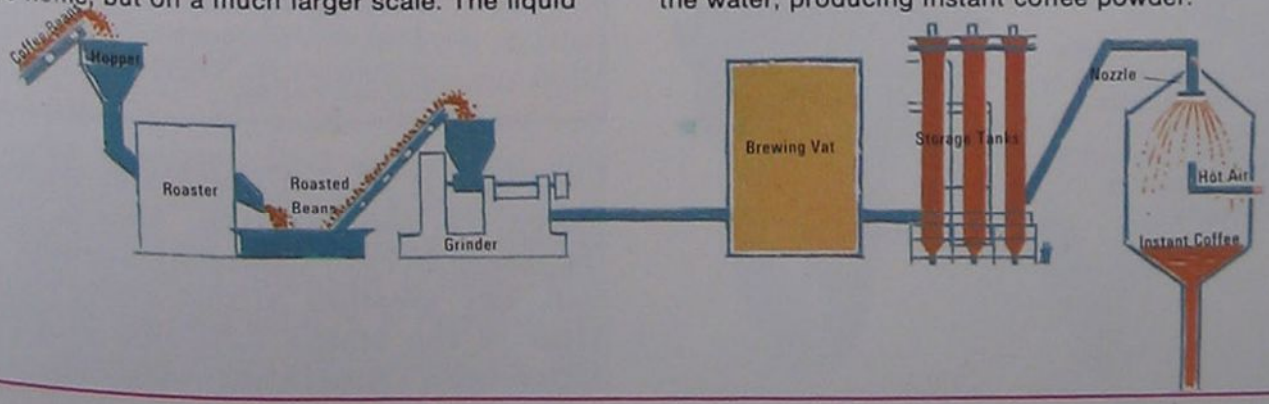
The best coffee is made by filtering hot water through freshly ground beans. A special filter coffee pot may be used, or a percolator. Alternatively, hot water can be poured on to ground coffee, and the hot drink decanted off when the powder settles. Many people drink *instant* coffee, as it is quick and easy to prepare. Instant coffee powder is made by evaporating huge amounts of prepared coffee. The powder dissolves in hot water to make a coffee drink instantly.

About half the world's coffee comes from Brazil, although the coffee plant came originally from Africa. Coffee grows best in warm highland regions with high rainfall. Coffee bushes grow to a height of about 15 feet. The beans are contained in the red berries that grow on the bushes. After the berries are harvested, the fleshy covering is removed and the beans left to dry for some weeks. The outer husks are then removed from the beans, and the beans are shipped from the coffee plantations to manufacturers who roast the beans. This process gives the beans their flavour. The roasted beans are then sold to the public, either ground or whole.

Above: Coffee beans grow on bushes that may grow to a height of 15 feet. Centre: The fruits, which are often called cherries, consist of two seeds (the coffee beans) surrounded by green pulp and a red-brown skin. Below: After harvesting, the skin and pulp are removed and the beans left to dry in the sun. The beans are laid out in large beds and raked to turn them over.



Instant coffee is made by roasting and grinding coffee beans and then brewing coffee in much the same way as in the home, but on a much larger scale. The liquid coffee is then separated from the grounds and stored before it is sprayed through hot air. This action removes the water, producing instant coffee powder.



Cologne is an ancient city on the River Rhine in West Germany. It is the country's third largest city, with a population of 866,308. In German, its name is *Köln*.

Cologne is famous for its magnificent Gothic cathedral, which was begun in 1248 and not completed until 1880. Cologne university was founded in 1388. The city is a shipping, finance and manufacturing centre. Its products include heavy transport equipment, chemicals, textiles, chocolate and the toilet water called *eau de Cologne*, which has been made there since 1709. Cologne was once a Roman colony and, in the Middle Ages, was a member of the Hanseatic League (see Hanseatic League). It was very badly damaged during World War II.

Colombia is a country on the Equator in the north-west of South America. Most Colombians live on the fertile lowlands on the Caribbean coast. Few live on the thickly-forested Pacific coast. Amerinds live in small villages in the forests of the

Above: Rubber is among the crops grown in Colombia. Here, workers tend young rubber tree seedlings in a rubber plantation. Right: Colombia is located at the north-west corner of South America.

Location map of the state of Colorado in the United States

southern part of the inland plain. Three great ranges of the Andes mountains cut across Colombia.

The country is rich in minerals, including gold, petroleum, salt and silver. But most people are farmers and the chief crop is coffee. Colombia is the world's second largest producer of coffee.

Most Colombians are *mestizos*, descendants of marriages between Amerinds and Europeans. An important group of Colombians are descended from Spanish settlers.

In the early 1500's, the Spaniards made Colombia part of their territory of New Granada. In 1819, Simon Bolivar, a Venezuelan revolutionary, drove out the Spaniards and founded a Republic of Greater Colombia, that included New Granada. The present republic of Colombia was set up in 1830, but until 1863 it was called New Granada. Panama broke away from Colombia in 1903. In the 1960's, Colombia and the United States jointly planned to build a new Caribbean-Pacific canal through northern Colombia.

Facts and Figures
Area: 439,513 square miles.
Population: 21,792,000.
Capital: Bogotá.

Colorado is one of the Rocky Mountain States of the western United States. Its magnificent mountain scenery and cool, dry weather attract many tourists. Most of the state's 2,207,000 people are native-born Americans – descendants of

prospectors, homesteaders and cowboys. The main cities are Denver, the capital and largest city, Pueblo and Colorado Springs.

Manufacturing, farming and mining are the state's chief sources of income. Farmers raise livestock, and grow sugar beets, hay, wheat and vegetables. In the 1800's, gold and silver mining flourished, but today petroleum, molybdenum and uranium are more important.

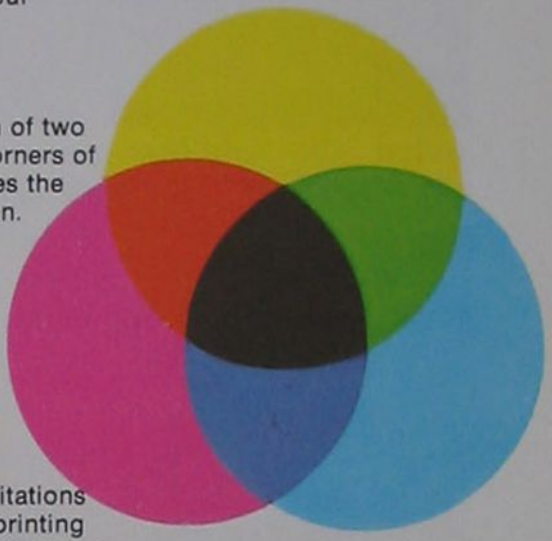
Cliff-dwelling Indians were the main inhabitants of the Colorado region when Spanish explorers arrived in the 1540's. The United States acquired the region by 1848, and Colorado became a state in 1876.

Colour 'White' light, which is sunlight, is a mixture of lights of different colours. If sunlight is passed through a glass prism the light will be split up into its constituent colours to form the *spectrum*. When white light shines on a red object, all its constituent colours are absorbed by the object, except red light, which is reflected back to the eyes. Similarly, a blue object absorbs all colours except blue. If white light passes through a sheet of red glass, the glass absorbs all the colours except red, which passes through as red light.

Just as colours can be separated from white light using a prism of pieces of coloured material, so they can be combined together again to give white. If beams of light from red, blue and green spotlights shine together onto a white sheet of paper, the paper will still appear white. This is because the colours red, blue and green are *primary colours* which mixed together will give white. Using these three primary colours, light of any colour can be made. Blue and red will make magenta. Red and green will make yellow. The *colour triangle* is a convenient way of finding out the results of mixing lights of different colours. The combination of two colours at the corners of the triangle gives the colour in between.

The additive colour triangle of light.

The combination of two colours at the corners of the triangles gives the colour in between.



The subtractive colour triangle of pigments.

Owing to the limitations imposed by the printing process, these colours may not be exactly correct.

Not all animals see an object in the same colours. These illustrations show how a bunch of flowers appears to a man (right), to a dog (below) and to many birds and fishes (below right).

When mixing coloured pigments (in the form of paints or dyes) a different kind of colour triangle is used. Here the three primary colours are *yellow*, *magenta* and *blue green*. Each primary pigment absorbs one of the 'primary' colours of light, and reflects back the other two. Yellow pigment, for example, absorbs blue light and reflects back red light and green light. These two are mixed by the eye to form yellow. Blue-green pigment absorbs red and reflects back blue light and green light. Magenta pigment absorbs green and reflects blue and red.

Coloured lights are mixed by what is called the *additive* process. Pigments are mixed by the *subtractive* process; the pigments absorb or *subtract* certain colours, and then reflect back other colours which the eye mixes.

Talking points

*The three primary colours in light are red, blue and green. If these three colours are projected on to a single spot on a sheet of white paper, they will combine to make a white light. Why do you think this is so? Try the experiment yourself, using torches and pieces of coloured glass.

*Some animals are less able to distinguish colours than Man. For example, dogs are almost colour-blind. How does this affect them and how do they make up for it?

*What is the connection between light passing through a glass prism and a rainbow?

Articles to read

Aurora; Dyes; Infrared; Light; Paints; Prism; Ultraviolet.

Colt, Samuel (1814-62), invented the first successful revolver. He was born in Hartford, in Connecticut, and patented a design for a revolver in the United States in 1836. This gun had a cylinder of several chambers, so that several shots could be fired before the pistol had to be reloaded. At first his invention was unsuccessful, but when fighting broke out between the United States and Mexico in 1846 the government ordered 1,000 Colt revolvers. In 1847 Colt set up his own factory using the most modern machines and methods, and eight years later he built the largest private arms factory in the world at Hartford. After Colt's death, his company produced the famous six-shooter which was widely used in the opening up of the West.

Columbia River One of the world's largest rivers, the Columbia flows 1,214 miles from the mountains of British Columbia to the Pacific Coast of the United States. It drops thousands of feet as it flows through the states of Washington and Oregon, and dams like the Grand Coulee and Bonneville provide cheap hydroelectric power as well as controlling floods. Its chief tributary is the Snake River.

The first Europeans to settle Columbia River were the explorers Lewis and Clark, in 1805. It was used by fur traders, and is now used to transport timber. It is famous for its salmon, and the lakes made by the dams are used for recreation.

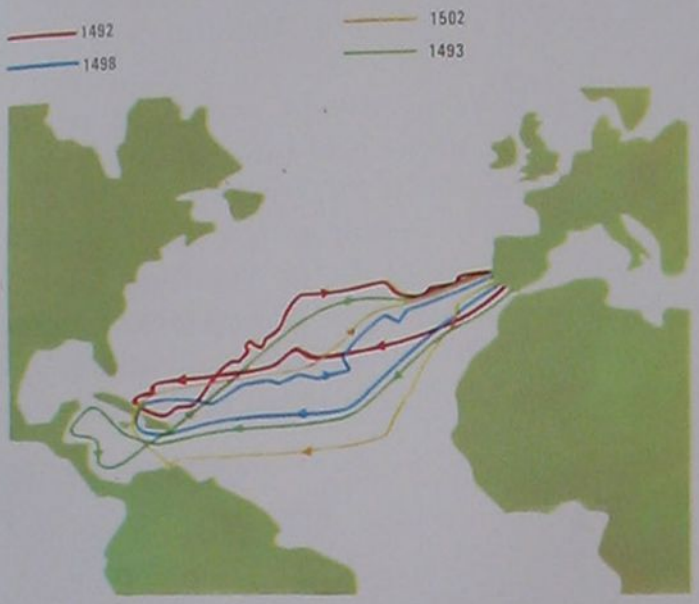
Columbus, Christopher (1451-1506), an Italian navigator, is said to have discovered America. He believed that the East could be reached by sailing westwards. He proved his theory, and opened up the 'New World' for Europeans.

Columbus was born in Genoa. He settled in Portugal and then Spain, where he adopted the Spanish form of his name, *Cristóbal Colón*. After many years he persuaded King Ferdinand and Queen Isabella of Spain to provide the money for a voyage of discovery.

On the 3rd August, 1492, Columbus set sail from Palos, in Spain, with 120 men in the *Santa María*, the *Pinta*, and the *Niña*. The ships were made of wood, and were very small. After nine days they stopped at the Canary Islands for nearly a month. Then, after a further three weeks' sailing, there was still no sign of land. This was the longest period that anyone had sailed in one direction out of sight of land. The crews were frightened and on the verge of mutiny.

On the 10th October, Columbus persuaded them to carry on for just another two or three days before turning back. Two days later they sighted an island in what is now the Bahamas. Columbus named it San Salvador. He thought he had reached the Indies, near China, and did not realize he had discovered a new land.

Left: A portrait of Christopher Columbus painted in Spain in the 1500s. Below: Columbus made four voyages to the New World. The trip from Spain to the West Indies took about a month. Right: Columbus bargained with the Indians when he set foot on land and eventually set up colonies. Below right: A model of Columbus' ship, the *Santa Maria*, in which he made his first voyage across the Atlantic Ocean.



Columbus received a hero's welcome on his return to Spain. On his three later voyages, Columbus explored other islands of the West Indies and sailed along the coast of Central America to Venezuela, where he and his men set foot on the great American continent.

Combustion When we set fire to a piece of paper, it burns quite rapidly. This is a very familiar form of combustion. Combustion is rapid *oxidation*, a chemical reaction in which a substance combines with oxygen. During combustion, energy is released as light and heat. If the release of energy is very fast, an explosion results.

But the term 'combustion' is sometimes used to describe slower forms of oxidation, which may produce little or no light and heat. A form of slow combustion, or oxidation, takes place in our bodies. Some of the food we eat is 'burned' in the cells of the body using oxygen brought by the blood. This process is called *internal respiration*. An even slower form of oxidation is the gradual rusting or *corrosion* of iron and steel in the air. This produces no light and scarcely any heat.

Rotting and decay are also slow forms of oxidation in which little heat is normally produced. But if a huge mass of material is decaying, the heat may build up until the whole mass bursts into flame. When a fire breaks out in this way, it is called *spontaneous combustion*. It often occurs in hayricks that have been made before the hay was completely dry.

Comet A comet is a collection of gas and dust a few miles across. Normally it is far too faint to be seen even with a powerful telescope. But when it approaches the Sun it becomes brighter, and can then

Although comets might be thought to be bright objects that flash across the sky, they are usually dim and move very slowly. For this reason long exposures are necessary to photograph them, and the background of stars may appear as lines as the camera follows the comet's motion across the sky. Above: Comet Alcock appeared in the sky in 1959. Below: The most famous comet of all, Halley's comet, appears every 76 years. It was last seen in 1910 and is expected again in 1986. It was seen as an omen before the Battle of Hastings in 1066.

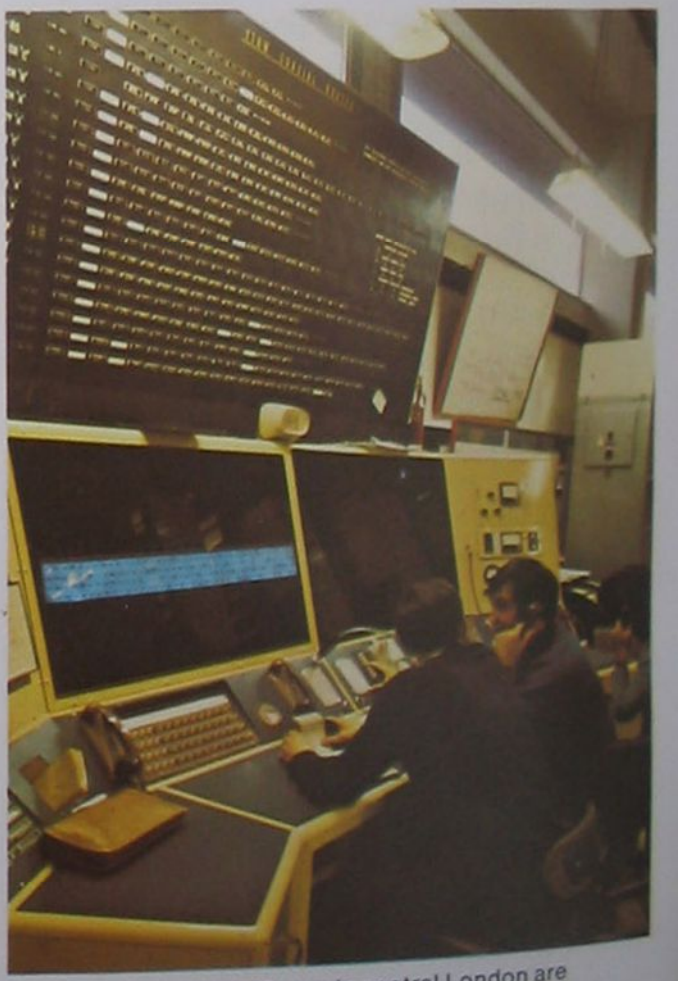
be seen with a telescope. Very occasionally a comet becomes bright enough to be seen with the unaided eye.

A comet appears as a bright ball of light. When close to the Sun it may have a long, glowing tail. The Sun's rays cause the gas contained in the comet to glow and spread out to form the tail. Night after night the comet moves slowly across the background of stars until it finally fades away.

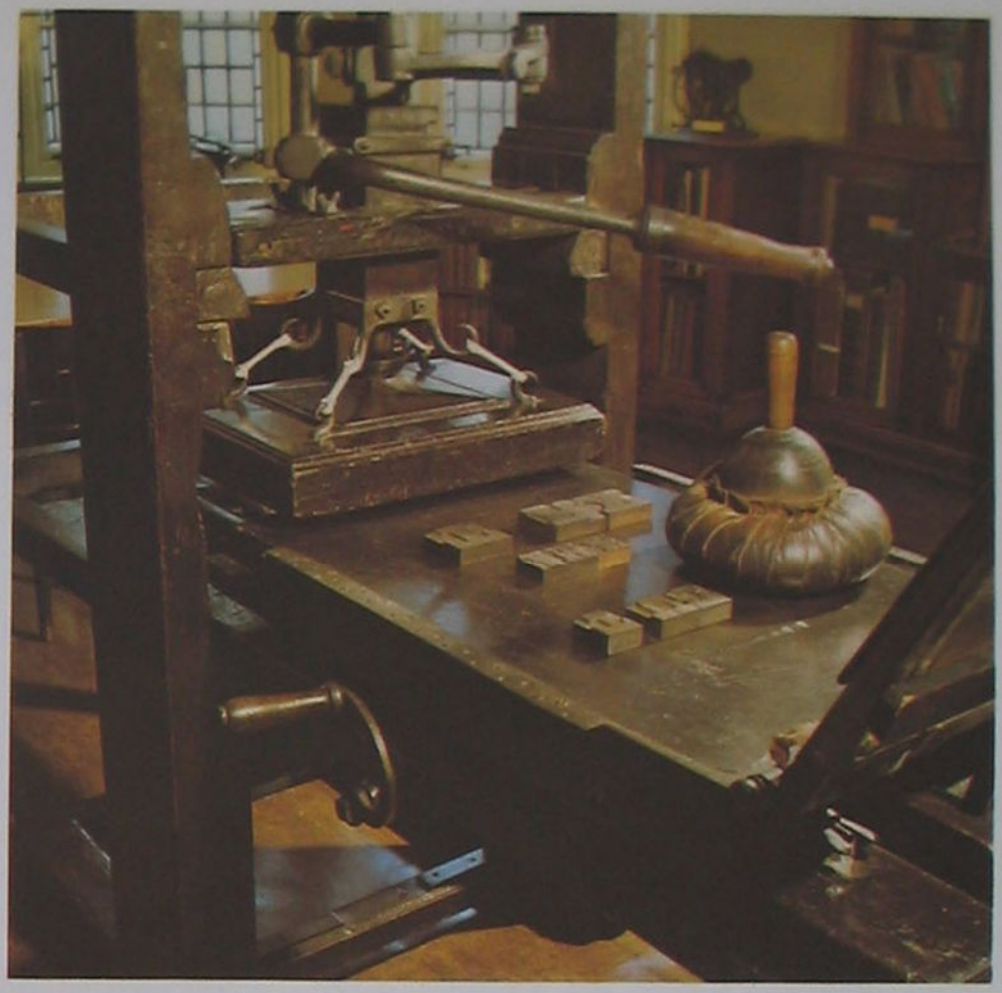
People used to think that a comet's sudden appearance in the sky foretold a terrible event on Earth. Later, astronomers discovered that comets are harmless bodies that travel in ellipses around the Sun.

Comets do not last for ever. Each time one passes the Sun it loses some of its gas until, eventually, only the dust particles are left. Sometimes the Earth crosses the path of a swarm of dust particles from a former comet which plunge through the Earth's atmosphere as 'shooting stars'. (See Meteors.)

Communications are the means by which we transmit ideas and information to one another. Methods of communication include words, gestures, pictures, books, telephones and all the *media* of mass communication, such as newspapers, films, radio and TV broadcasts and advertisements. Modern techniques of communica-



Inside the Post Office Tower in central London are control centres for radio and television broadcasts as well as telephone equipment.



Gutenberg's invention of the movable type printing press was a major breakthrough in the development of communications. Gutenberg first used his machine in Germany in the 1450's. He printed Bibles which at that time were almost the only source of reading matter.

tion have made it possible for people thousands of miles apart to communicate with each other, and for any one man to communicate with millions of others. But improvements in communication do not necessarily lead to improvements in understanding. The value of any communication depends on the truth and merit of the idea or information it transmits.

For thousands of years men relied almost entirely on face to face contact. They were limited to what they could say or else express in signs and movements. Then, about 6,000 years ago, the Egyptians and others devised systems of writing. These enabled men to communicate over longer distances, and also to span time, because written words can be preserved and read by later generations of men.

Until the mid-1400's, books had to be copied by hand, which was very slow. Then Johannes Gutenberg's invention of printing with movable type made books much more widely available. Today, hundreds of millions of books, magazines and newspapers are printed each year. And vast quantities of printed material can be preserved and stored in a tiny space by the use of microfilm.

In the 1800's, photography and some electronic methods of communication—including the telegraph and telephone—were invented. In 1895 Guglielmo Marconi constructed the first working wireless telegraph or radio. This development was one of the most revolutionary in the history of communications: for the first time a man could speak directly to another man who was a long distance away and who was not connected to him by wires or any other physical means. Television, the transmission of pictures in the same way, was developed by the 1930's. Today, communications satellites help to send radio and TV transmissions over vast distances.

Communism One meaning of the word 'Communism' is groups of people who do

not have their own property but arrange for it to be owned by the group as a whole. From the group, each individual receives what he needs, and he works for the group to the best of his ability. Early Christians were among those trying to follow this practice. Communism also means the political movement which aims to bring about this state by means of revolutionary change. It is based on the ideas of Karl Marx (see Marx, Karl).

Marx believed in a constant conflict between the different classes into which people are divided. In countries where industry had developed (see Industrial Revolution) the ruling class included the factory owners, or capitalists. Marx believed that the workers would be oppressed by the capitalists until a revolution took place. When this happened the workers would seize power and would then control the government as well as industry and trade. Marx called this the 'dictatorship of the proletariat'. This, he believed, would develop eventually into a Communist society where there were no classes. In a number of countries, including Russia, Social Democratic parties were set up by people believing in Marx's ideas. V. I. Lenin (1870-1924) led a group of Russian Social Democrats known as Bolsheviks. In March 1917 the Russian Czar was overthrown. After this the government was in the hands of the middle classes and Lenin worked for another revolution. This broke out in Petrograd (then the capital) in November 1917 (October by the old Russian calendar). The Bolsheviks seized control and the leaders of the party formed a government. Industry was taken from private owners, workers ran the factories, and private trading was abolished. The government was not able to control everything, and there was much opposition. But by ruthless methods the Bolsheviks (renamed Communists) remained in power.

The Chinese Communist Party was set up in 1921. Mao Tse-tung (born 1893) became an important leader after the Long March of 1935 when the Communists went to Northern China. Chinese Communists gathered support from the peasants whom Mao Tse-tung made a revolutionary and a military force. This was important in the seizure of power which took place in 1949. Peking was captured and the People's Republic of

Street fighting in St Petersburg (modern Leningrad) during the 1905 revolution in Russia. Although it failed, this uprising was later regarded as 'a dress rehearsal for the real revolution of 1917'.

Communist Countries

Above: Colourful posters exhorting the people to greater effort are a feature of a Communist state. The Russian poster on the left is entitled 'The Five-Year Plan' and dates from 1933. It portrays a sharp-nosed capitalist dismissing the aims of the plan as fantasy, and then being overwhelmed by its achievements. The poster on the right, 'If War Breaks Out Tomorrow', is a Russian poster from 1938.

China set up with Mao Tse-tung as its Chairman (i.e. President). He retired from this office in 1959 but still has tremendous influence through his much-quoted writings – the Thoughts of Mao Tse-tung.

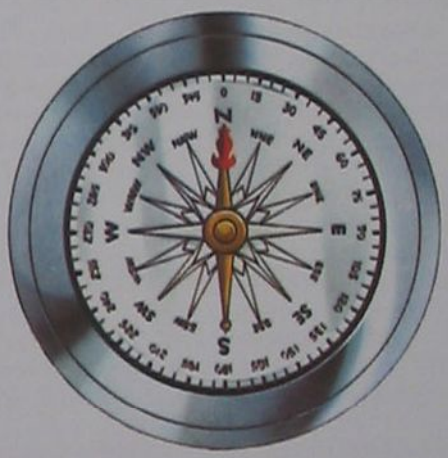
In countries in Eastern Europe, in Cuba and elsewhere there are Communist governments. In most of these countries the Communist Party is the most important or is the only party. Its members form small but active groups.

The world Communist movement is today divided between those who believe that socialism will be won by civil war, and those who believe that in parliamentary democracies constitutional methods can be used. Most Communists believe that Communist and capitalist states need not fight wars, but supporters of Mao Tse-tung think such wars are inevitable.

Compass This is a device which shows the direction of North. It is widely used by mariners and aircraft pilots, and more recently by navigators of automobiles, to find their way about and to fix their position relative to landmarks.

There are three basic types of compass. The most familiar is the *magnetic* compass. This works on the principle that when a magnet is free to revolve it will always come to rest pointing towards the Magnetic North Pole of the Earth. A simple magnetic compass can be made by floating a magnetized needle in a saucer of water.

Unfortunately, the Magnetic North Pole is not in exactly the same position as the true North Pole, and, what is more, its position varies slightly each year.



A simple pocket compass with a fixed card beneath a moving needle. The red pointer always swings round to point North, and the compass is turned so that the pointer's tip aligns with the letter N.

Because of this, a correction must be made to all measurements made with a magnetic compass.

The other two types of compass are the *gyrocompass*, which responds to the rotation of the Earth, and the *solar* or *star* compass, which measures direction relative to the Sun, or to a star.

Composers are generally thought to be essential for the creation of music, but much of the world's music is *improvised* (made up as it goes along) by the people playing it. Almost all Eastern music is

continued on page 316

GREAT COMPOSERS

Bach, Johann Sebastian (German) (1685-1750): Cantatas; choral works (esp. *St Matthew Passion*); clavier and violin concertos; masses; suites; many organ and clavier pieces. *Brandenburg Concertos Nos. 1-6.*

Bartók, Béla (Hungarian) (1881-1945): Ballet suites; choral and orchestral works; piano and violin concertos; one opera; much folk music. *Concerto for Orchestra.*

Beethoven, Ludwig van (German) (1770-1827): Choral works; piano and violin concertos (one Triple Concerto for piano, violin and cello); nine famous symphonies; masses; overtures and incidental music; one opera and an oratorio; much chamber- and piano music. *Symphony No. 7.*

Berlioz, Hector (French) (1803-1869): Unusual programme symphonies; choral works (esp. *Te Deum*); operas; orchestral songs; overtures; a Requiem Mass. *Fantastic Symphony.*

Bizet, Georges (French) (1838-1875): Operas and suites; one symphony. *Carmen.*

Borodin, Alexander (Russian) (1833-1887): Symphonies; one opera; chamber-music. *Symphony No. 2.*

Brahms, Johannes (German) (1833-1897): Choral and orchestral works; four famous symphonies; piano and violin concertos (one Double Concerto for violin and cello); dances; concert-overtures; a *German Requiem*; songs; much chamber- and piano music. *Violin Concerto.*

Britten, Benjamin (British) (1913-): Piano and violin concertos; symphonies; operas; orchestral works. *Variations and fugue on a theme of Purcell* (also known as *The Young Person's Guide to the Orchestra).*

Bruckner, Anton (Austrian) (1824-1896): Symphonies; masses, and other large scale religious and secular choral works. *Symphony No. 4.*

Chopin, Frédéric (Polish) (1810-1849): Concertos and other works for piano and orchestra (the ballet *Les Sylphides* is based on his piano music). Almost exclusively a composer for the piano. *Piano Concerto No. 1.*

Copland, Aaron (American) (1900-): Symphonies; operas; ballet music, chamber-music. *Dance Symphony.*

Debussy, Claude (French) (1862-1918): Orchestral works; one opera; chamber-music; songs and piano music. *Images.*

Dvorák, Antonín (Czech) (1841-1904): Piano, violin and cello concertos; symphonies; concert-overtures; dances; symphonic poems; operas; choral works; a Requiem Mass; chamber-music. *Symphony No. 9 (From the New World,* formerly known as *No. 5).*

Elgar, Sir Edward (British) (1857-1934): Choral works (esp. *The Dream of Gerontius*); violin and cello concertos; two symphonies; concert-overtures; *Pomp and Circumstance* marches; suites; chamber- and organ music. *Enigma Variations.*

Falla, Manuel de (Spanish) (1876-1946): Ballets; operas; suites; one work for piano and orchestra *(Nights in the Gardens of Spain)*; chamber- and piano music. *Love the Magician*—suite.

Franck, César (Belgian) (1822-1890): Operas; oratorios; symphonic poems; one symphony; organ and piano music; one famous violin sonata. *Symphonic Variations* for piano and orchestra.

Gluck, Christoph Willibald (German) (1714-1787): Operas. *Orfeo et Euridice.*

Gounod, Charles (French) (1818-1893): Masses and other religious music; operas; oratorios; symphonies. *Faust.*

Grieg, Edvard (Norwegian) (1843-1907): Dances and suites; chamber- and piano music; songs. *Piano Concerto.*

Handel, George Frideric (German, naturalized British subject) (1685-1759): Concertos for various instruments (esp. many organs); operas; oratorios (esp. *Messiah*); suites; church and chamber-music. *Water Music*—suite.

Haydn, Joseph (Austrian) (1732-1809): Concertos for various instruments; over 100 symphonies; operas; masses; chamber-music. *Symphony No. 100 (Military).*

Holst, Gustav (British) (1874-1934): Choral works; concertos for various instruments; operas; suites; chamber-music. *The Planets*—suite.

Khatchaturian, Aram (Russian) (1903-): Suites; symphonies; a violin concerto; chamber-music. *Piano Concerto.*

Kodály, Zoltán (Hungarian) (1882-1967): Choral works; dances and suites; one (comic) opera and one symphony; folk music. *Háry János*—suite.

Lalo, Edouard (French) (1823-1892): Violin and cello concertos; operas; suites; one symphony. *Symphonie Espagnole* for violin and orchestra.

Leoncavallo, Ruggiero (Italian) (1858-1919): Operas. *I Pagliacci.*

Liszt, Franz (Hungarian) (1811-1886): Two piano concertos and other works for piano and orchestra: *Hungarian Rhapsodies*; symphonies and symphonic poems; masses; oratorios; piano and organ music. *Piano Concerto No. 1.*

Mahler, Gustav (Austrian) (1860-1911): Symphonies; orchestral songs and song-cycles (esp. *Song of the Earth). Symphony No. 1 (Titan).*

Massenet, Jules (French) (1842-1912): Operas. *Manon.*

Mendelssohn, Felix (German) (1809-1847): Piano and violin concertos; symphonies (esp. the *Italian*); choral works; oratorios; concert-overtures; chamber- and piano music; songs. *Violin Concerto.*

Mozart, Wolfgang Amadeus (German) (1756-1791): Concertos for various instruments (esp. many piano); many symphonies, divertimenti, operas, serenades, masses (one Requiem); chamber- and piano music. *Symphony No. 41 (Jupiter).*

Mussorgsky, Modest Petrovitch (Russian) (1839-1881): Operas; orchestral works; songs. *Boris Gudunov.*

Prokofiev, Serge (Russian) (1891-1953): Piano, violin and cello concertos; ballet music; operas; suites; symphonies; *Peter and the Wolf* for narrator and orchestra; chamber- and piano music. *Piano Concerto No. 3.*

Puccini, Giacomo (Italian) (1858-1924): Operas. *La Bohème.*

Rachmaninov, Serge (Russian) (1873-1943): Piano concertos and *Rhapsody on a theme of Paganini* for piano and orchestra; symphonies and symphonic poems; operas; dances; chamber- and piano music; songs. *Piano Concerto No. 2.*

Ravel, Maurice (French) (1875-1937): Piano concertos; ballet suites; orchestral works; orchestrations of works by Debussy, Mussorgsky, etc.; chamber- and piano music; songs. *Daphnis and Chloé.*

Rimsky-Korsakov, Nicholas (Russian) (1844-1908): Operas; orchestral works; symphonies; one piano concerto; chamber-music and songs. Completed works by Mussorgsky and Borodin. *Scheherazade.*

Rossini, Gioàcchino (Italian) (1792-1868): Operas; religious music; chamber-music; songs. *The Barber of Seville.*

Saint-Saëns, Camille (French) (1835-1921): Piano, violin and cello concertos; operas; symphonies and symphonic poems (esp. *Danse Macabre*), a Requiem Mass; chamber- and piano music. *Carnival of the Animals* for two pianos and orchestra.

Scarlatti, Domenico (Italian) (1685-1757): Operas; masses; sonatas for harpsichord. *Harpsichord Sonatas.*

Schönberg, Arnold (German) (1874-1951): Operas; chamber- and piano music. Originator of twelve-note system of composition. *Pierrot Lunaire.*

Schubert, Franz (Austrian) (1797-1828): Symphonies; masses; chamber- and piano music; songs and song-cycles. *Symphony No. 9* (*The Great*, formerly known as *No. 7*).

Schumann, Robert (German) (1810-1856): Piano, violin and cello concertos; symphonies; a Requiem Mass; one opera; chamber- and piano music; songs. *Piano Concerto.*

Shostakovich, Dimitri (Russian) (1906-): Piano, violin and cello concertos; symphonies, operas; music for films; chamber- and piano music. *Piano Concerto No. 2.*

Sibelius, Jean (Finnish) (1865-1957): Symphonies; symphonic poems; choral works and incidental music; one violin concerto; songs. *Symphony No. 5.*

Smetana, Bedřich (Czech) (1824-1884): Symphonic poems (esp. *Vltava*); operas; chamber-music. *The Bartered Bride.*

Strauss, Richard (German) (1864-1949): Violin, horn and oboe concertos; *Burleske* for piano and orchestra, and a Double Concertino for bassoon and clarinet; symphonies and symphonic poems; operas (esp. *Der Rosenkavalier*); chamber-music and songs. *Till Eulenspiegel's Merry Pranks.*

Stravinsky, Igor (Russian) (1882-1971): Piano and violin concertos; symphonies; operas; ballet music (esp. *The Firebird*); miscellaneous orchestral works; piano music. *The Rite of Spring.*

Tchaikovsky, Peter Ilitch (Russian) (1840-1893): Piano and violin concertos, and works for cello and orchestra; seven symphonies (including *Manfred*); orchestral works; operas; ballet music (*Swan Lake* etc.); chamber- and piano music. *Piano Concerto No. 1.*

Vaughan Williams, Ralph (British) (1872-1958): Piano, violin, oboe and tuba concertos; symphonies (esp. *Pastoral*); fantasias; operas; choral works; one mass; chamber-music; songs. *Fantasia on a theme of Thomas Tallis.*

Verdi, Giuseppe (Italian) (1813-1901): Operas; a Requiem Mass and other religious music; one string quartet. *Aida.*

Vivaldi, Antonio (Italian) (c. 1675-1741): Over 500 concertos for various instruments; religious music. *The Four Seasons.*

Wagner, Richard (German) (1813-1883): Operas (*Tannhäuser, Lohengrin*, etc.); one early symphony. *The Mastersingers.*

Walton, Sir William (British) (1902-): Violin and viola concertos, and a Sinfonia Concertante for piano and orchestra; symphonies; operas; overtures and marches; one oratorio (*Belshazzar's Feast*). *Symphony No. 1.*

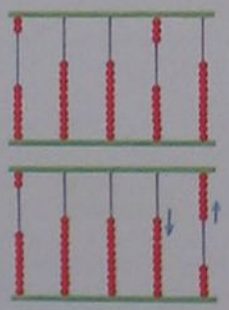
Weber, Karl Maria von (German) (1786-1826): Piano, bassoon and clarinet concertos, and a *Konzertstück* for piano and orchestra; symphonies; operas; masses, piano music; songs. *Der Freischutz.*

Left: Tchaikovsky. Below: A cartoon of Wagner. Right: Debussy. Far right: Stravinsky.

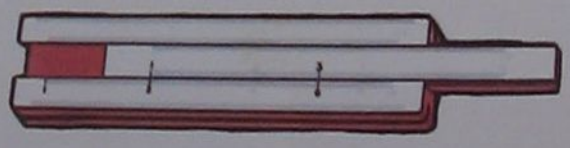
improvised, as well as much folk music. Jazz music, too, is largely improvised. But music that is intended to last has to be written down, so that it will not change from performance to performance. This kind of music arose in Europe about 400 years ago, and most of the great composers have come from Europe.

Computer This is a machine for performing rapid mathematical calculations. In a way, the cash register which adds up bills in a supermarket or the adding machines which do calculations in banks and offices are kinds of computers. But today the word is taken to mean an electronic computer, which can perform highly complex calculations quickly and accurately.

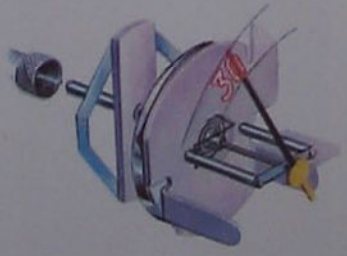
There are two main types of computers: *digital* and *analogue*. A digital computer uses electronic circuits to make calculations. The information fed into the machine is called the *input*. Special typewriters convert the information into a series of holes on punched cards or paper tapes. A card-reader or tape-reader converts these into a series of coded electrical signals which can be 'understood' by the computer. For instance, numbers must be converted into a series of electrical pulses. The principle is similar to that of the Morse Code used in telegraphs and radio. But instead of a series of short and long pulses (dots and dashes), computer codes use 'on' and 'off' pulses. In this code, called the *binary* code, the figure 2 is represented as 10, or one 'on' pulse and one 'off' pulse. Figure 3 is 11, or two 'on' pulses; figure 4 is 100, or one 'on' and two 'off' pulses; and so on. The binary code is the 'language' of the computer.



Left: The abacus is a form of digital calculator that is widely used. Here, the abacus is being used to multiply 2 by 3. Two beads (the number indicated in the first column) are lifted in the last column every time one of the three beads is dropped in the fourth column. The result, six, appears as the number of beads lifted in the last column.



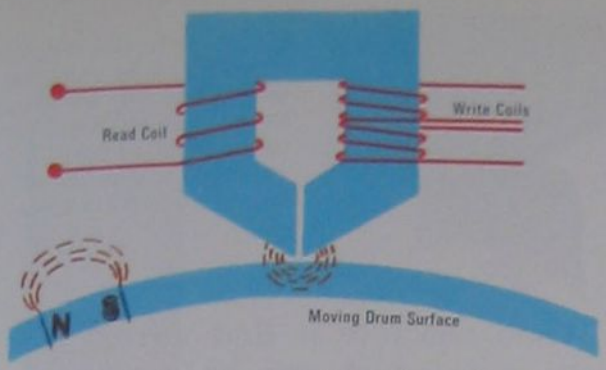
Analogue computers represent quantities by physical magnitudes, as in the slide rule (above) and a speedometer (below right). In digital computers, the quantities are represented by actual numbers or digits, as in the milometer (below left).



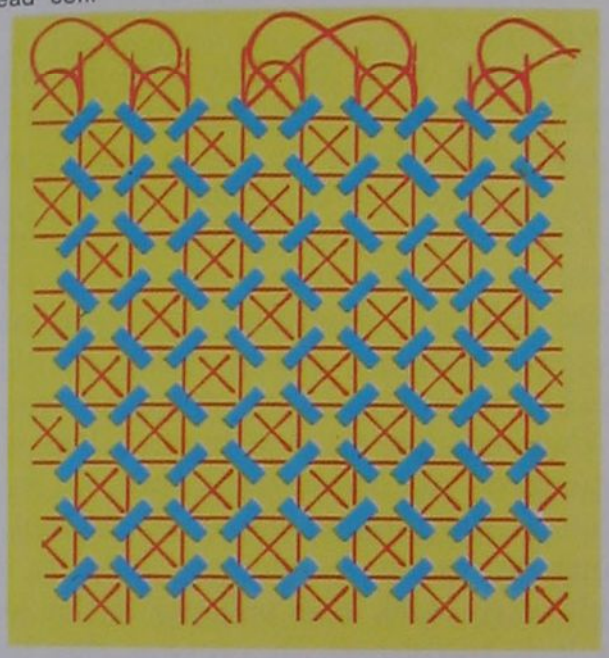
An analogue computer is used when the input information is varying with time. For example, a clock is a simple analogue device. Its hands indicate time, a continuously varying quantity, by pointing to numbers on a scale. Practical problems can be solved by making an apparatus which generates varying electrical voltages corresponding to the quantities being studied. The computer can 'read' these voltages and perform calculations using them. In this way, the computer can reproduce or *simulate* the effects of changing conditions. One important application is the flight simulator used to train pilots to fly aircraft. The machine can reproduce all the conditions in the cockpit of an aircraft without the danger of the learner pilot having actually to fly.

The way a computer tackles a problem depends on how it is prepared for the task. Preparation includes giving the machine its instructions and these are called the computer *program*. *Data*, all the facts for possible future reference, are stored in the computer's memory. The store may be a collection of magnetic drums, discs, or tapes which record electrical impulses in the same way as a tape recorder does.

Computers present answers to problems as *output*. This may take the form of printed characters on paper from a tele-



Information can be stored on the surface of a drum in the form of tiny magnetic patches formed by a 'write' current passing through the read-write head. When these patches pass the head later, they induce signals in the 'read' coil.

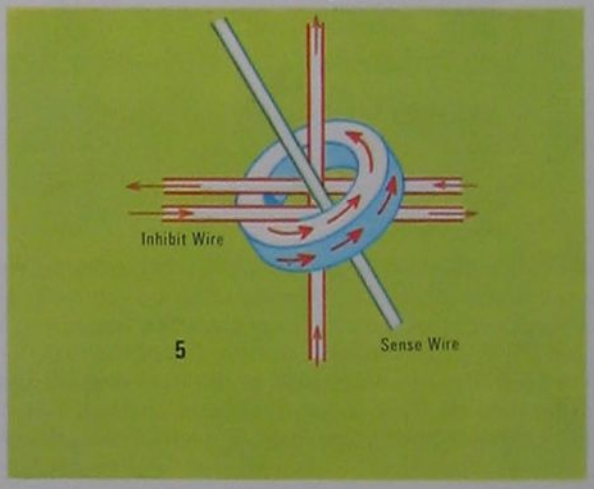


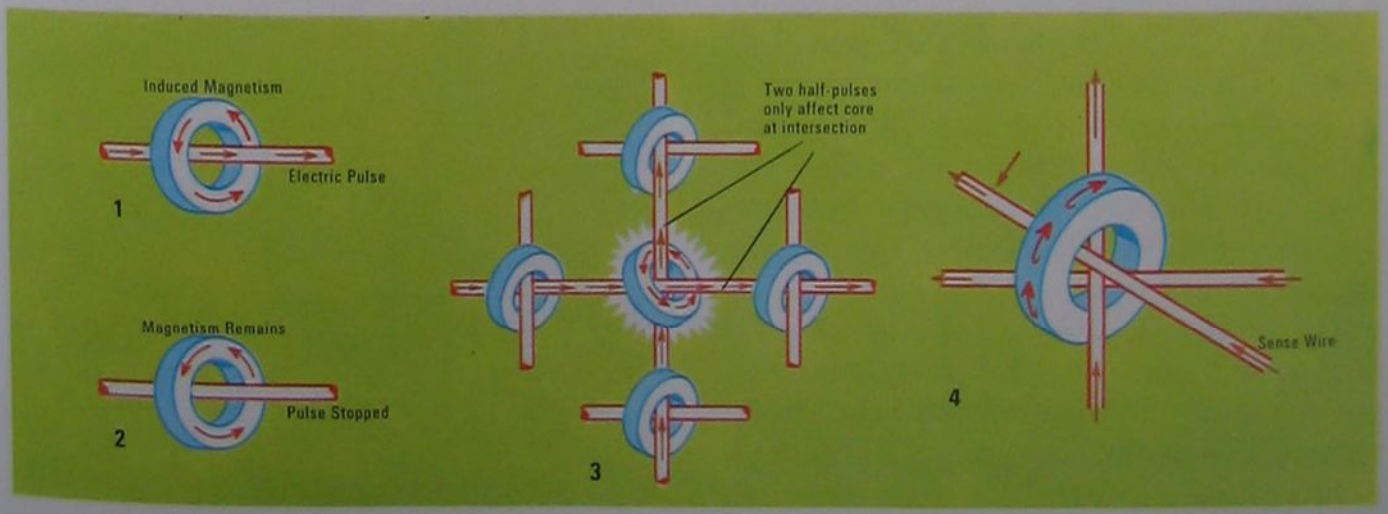
Computers may store information in memory cores. Above: the cores are connected in memory *units*. Below and right: Signals pass through the cores to write information or read the memory. The cores are magnetized by an electric pulse (1) and (2). Individual cores in a memory unit are selected by passing a half pulse through two wires. Only the core at the intersection of the wires is affected (3). The polarity of the core depends on the direction of the pulse. A sense wire produces a signal when the polarity changes (4). An inhibit wire is used to cancel out any single half-pulses and prevent them affecting the core (5).

printer, more punched cards or paper tape, or the results may be displayed on a television screen.

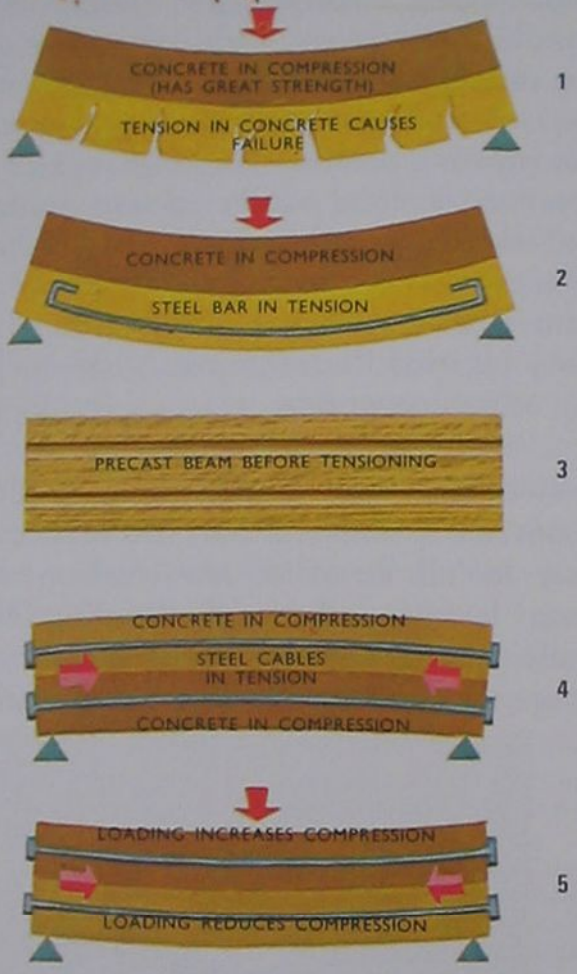
At first computers were used as glorified adding machines for keeping accounts and solving complex mathematical problems. But today they have many varied applications. Airlines use computers to handle reservations, flight schedules, and the organization of their staff. Computers can set the type for a book and control the printing presses. They can control the running of steel works, power stations, and docks. Weather forecasting, library information services, and hospitals can benefit from computers. Computers can even be used to design machines, including other computers.

Concrete is one of our finest building materials. Millions of tons are used every year in all forms of construction work from laying paths and building brick walls in the garden to building skyscrapers, dams and bridges, and roads.





Left: A reinforced concrete arch bridge. As compressive forces only are set up in the arch, the maximum use is made of the mechanical strength of the reinforced concrete.



Above: Concrete has strength when compressed, but is weak under tension (1). Reinforcing the concrete by embedding steel bars in it transfers the tension to the bars (2). In prestressed concrete, steel bars are threaded through holes cast in the concrete (3) and put under tension. This action produces compression throughout the concrete making it very strong (4) and (5).

When concrete is first mixed, it is a pasty mass which can be moulded into any shape. But it quickly sets rock-hard. It can be used under water, too. It is cheap, easy to make and is waterproof and fireproof.

Concrete may be cast into its final position in wooden moulds. Or it may be *precast* into shape in, say, a factory and then assembled on the building site.

For large construction projects, concrete is usually mixed on site in concrete mixers. Sometimes, however, concrete is supplied ready mixed in huge trucks and poured directly into place.

Concrete has great strength when it is squeezed, or *compressed*, but is weak when it is stretched, or under *tension*. A concrete beam supported only at its ends may crack and collapse if the load on it is too great. To prevent this happening, concrete can be strengthened, or *reinforced*, with steel bars or wires to give it strength under load.

The strength of reinforced concrete

Concrete is made by adding water to a mixture of cement, sand, and gravel or stone. The cement and water form a paste which binds the sand and gravel or stone together. The sand, called the *fine aggregate*, fills in the gaps between the gravel or stone, called the *coarse aggregate*, to form a solid mass.

The most common kind of cement used is Portland cement. This is a fine grey powder made by heating a crushed mixture of limestone, clay, and iron ore in a rotating kiln.

Below: In laying reinforced concrete, reinforcing bars are laid first and the concrete is poured on top of them. To ensure that the concrete fills the network of bars without air pockets, it is usually compacted by vibration.

Water vapour in the atmosphere condenses on any cold object, such as a glass containing a refreshing iced drink.

can be further improved by stretching, or *tensioning*, the wires or rods before or after concreting. The tension in the wires compresses the concrete and therefore makes it stronger. Concrete made in this way is called *prestressed*.

Condensation occurs when air has more water vapour than it can hold. Excess water vapour (a gas) *condenses* into water droplets. Air may be cooled until it reaches a temperature, known as the *dew point*, below which it is unable to hold all of its moisture in the form of vapour. When the temperature of a solid object falls below the dew point of the surrounding air, water vapour will begin to condense on it. This is why the outside of a glass containing an iced drink is soon covered by a film of water if it is in a warm room.

Condensation always needs encouragement in the form of something solid. Condensation in the atmosphere takes place on solid particles that are always in the air, such as salt crystals, smoke dust, and pollen. Such particles are called *condensation nuclei*. Condensation in the atmosphere produces cloud (and ultimately rain), or, at low levels, fog. Condensation also causes the dew that is found on objects close to the Earth's surface in the early morning.

Rain can sometimes be made to fall by spraying clouds with crystals of silver iodide. These help ice crystals to form, and make up for a lack of condensation nuclei in the air. (See Clouds; Dew; Fog; Rain.)

Conductivity is a measure of how well electricity or heat travels through a substance. Substances that are good conductors of electricity have atoms whose *electrons* (negatively charged particles) are free to move from atom to atom. These substances include silver and other metals. Liquid solutions and certain gases can also conduct current because they have free *ions* (charged molecules). Non-metals, such as glass, wood and rubber, are generally poor conductors. Poor conductors are called *insulators*. Electric flex consists of copper wire, a good conductor, surrounded by rubber insulation.

Substances that are neither good conductors nor good insulators are called *semi-conductors*. Their special properties —being able to conduct current in one direction only, or increased conductivity when heated—make them useful in transistors, rectifiers and other electronic components. Silicon, selenium and germanium are semi-conductors.

Heat travels through a substance because moving electrons in the heated portion knock against neighbouring electrons and set them in motion. Again,

The metal used in saucepans and frying pans is an excellent conductor of heat. Heat from the burner travels through the metal by setting in motion the electrons in the metal. This heat is then transmitted to the food.

metals are excellent heat conductors, and non-metals poor ones. You may notice that a metal spoon in a cooking mixture soon becomes too hot to handle, but a wooden one will remain cool. Liquids and gases generally transmit heat slowly.

Confectionery Confections of all kinds—sweets such as chocolates and toffees, sweet biscuits and cakes and pastries—have one ingredient in common: sugar. To this, various other foods are added, such as milk, butter, nuts, fruit, eggs and flour. Most, but not all, confections are cooked, and most contain flavourings and colouring ingredients.

The ancient Egyptians made sweets of honey and nuts. Early apothecaries made sugar coatings for their medicines. In about the 1200's, confectioners in Europe began making a few fancy sweetmeats, but only for the very rich. It was not until the 1800's, when refined sugar became widely available, that ordinary people could enjoy such delicacies. Today, most sweets are made in factories by machines, although some expensive chocolates and other sweets are still hand made.

A basic step in the making of most sweets is the boiling of a sugar and water syrup. The length of time the syrup boils determines how hard the sweet will be. For hard sweets, such as fruit drops, the syrup is boiled for a long time, and it becomes rock hard when cooled. Softer sweets, such as toffees and fondants, are made by cooking the syrup for a shorter time. Other ingredients are added and the mixture is sometimes whipped or pulled to give the right texture.

Confucius was a Chinese philosopher who lived five hundred years before the birth of Christ. Confucianism is not a religion, but a philosophy of man's behaviour towards his fellow men.

When Confucius was fifteen years old he decided to become a scholar. He mastered the teachings of the sages, or 'wise men' of China, and from these developed

Confucius lived about 2,500 years ago but his ideas live on in the lives of some 300 million people.

his own philosophy. When he was twenty-one, students started coming to him. The basis of his teaching was the Golden Rule: "Do not do unto others as you would not have others do unto you."

After he had taught for thirty years, a powerful Duke appointed him governor of a town. Here he put his teachings about good government into practice. The town prospered and its people revered Confucius almost as a god. But neighbouring leaders grew jealous, and he was forced to resign.

From this time until his death, Confucius tried to find another ruler who would listen to him. But most rulers of his time did not understand his ideas.

When he died, Confucius had only a few followers, but these men recorded his teachings and spread them. Today there are about 300 million Confucianists.

Congo This independent nation in western Africa was formerly known as the French Congo. Its capital is Brazzaville, and it used to be called Congo (Brazzaville) to distinguish it from its large neighbour Congo (Kinshasa), now called the Zaïre

Location map of Congo.

The centres of chocolates go through a chocolate-covering machine; the woman on the right makes a squiggle in the chocolate on top of each. The making of sweets is now a vast industry.

The world's largest easter egg was made in Liverpool, England in 1971 and weighed 550lb. It contained over £200 worth of chocolate. The biggest eaters of confectionery are the Scots, who ate 9 ounces of sweets per week per person in 1968. Confectionery is big business; about 1,320 million dollars are spent on it in the United States every year. The earliest record of confectionery dates back to 2000 B.C. in ancient Egypt.

Republic. Congo has an area of 129,960 square miles and a population of 915,000.

Timber is an important export, and crops include bananas, rice and maize. Roads are difficult to build because of the thick forests and heavy rains, and most goods are carried by river. The Congo was a French territory until 1960.

Congo River The Congo is the second longest river in Africa and the fourth longest in the world. It is 2,700 miles long, and drains an area of 1,400,000 square miles in west-central Africa.

The Congo rises in the south-east of the Zaïre Republic (formerly known as Congo, Kinshasa). Where the river runs through the Republic, it is also known as the Zaïre. A few miles north of the Equator the river sweeps over the Stanley Falls, and below this ships can sail for 1,000 miles down the river to where it widens into Stanley Pool. South of the pool, below Kinshasa, the river rushes over some 30 rapids.

The Congo empties into the South Atlantic through a 90-mile estuary, 7 miles wide, that continues out to sea for a further 100 miles along a deep channel.

The mouth of the Congo was discovered in 1483 by Portuguese explorers, but Henry Morton Stanley was the first to reveal the river's extent in the 1800's.

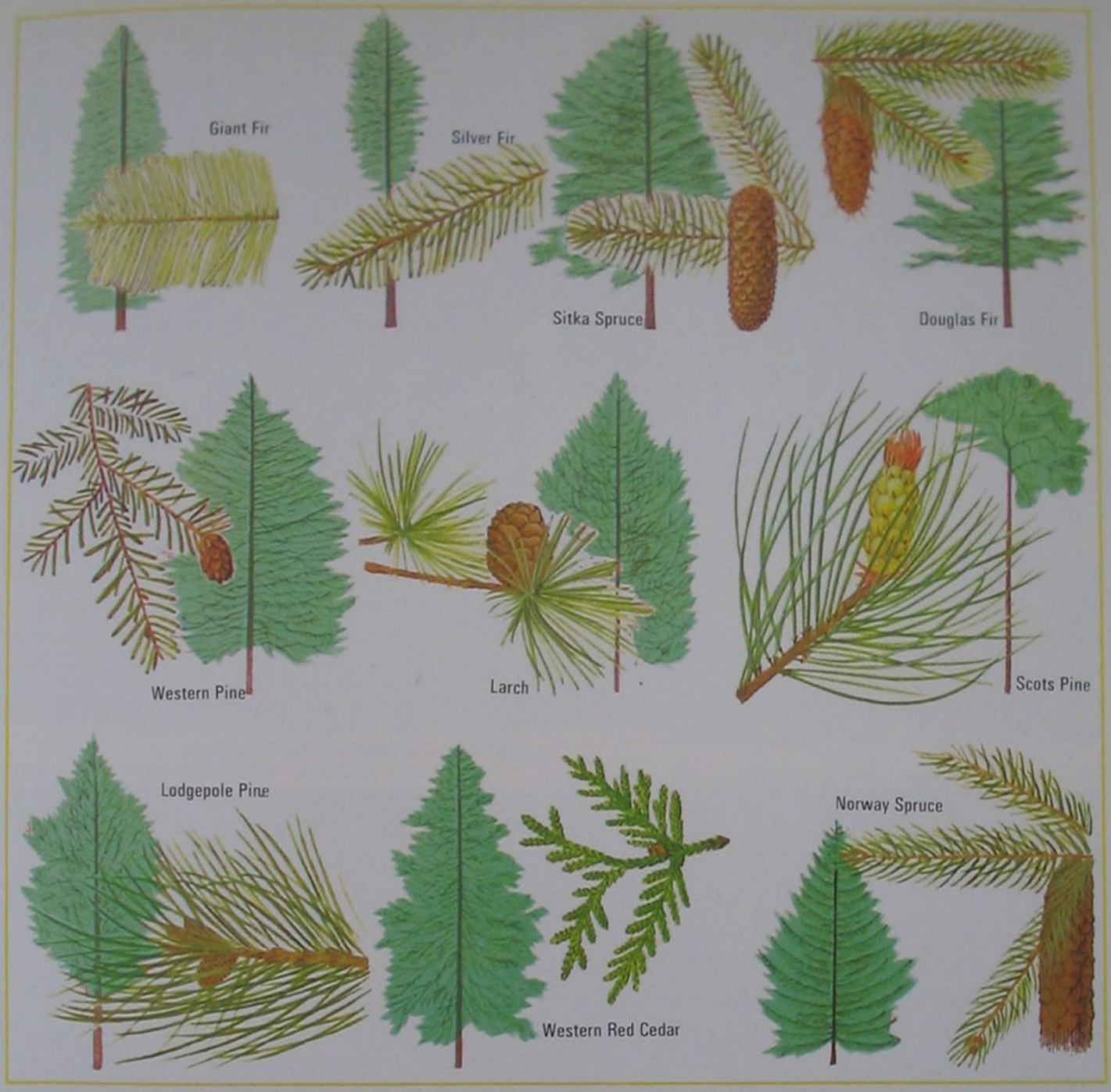
Conifers are trees or bushes that bear cones. Common conifers include the cypresses, cedars, Douglas fir, junipers, larches, spruces and Scot's pine. Botanists know of some 600 species of conifers which make up an important part of the vegetation of the cooler parts of the world. Although they do not compare in numbers with the more successful 250,000-strong list of flowering plant species, conifers do include two unique record-holders: the largest and the oldest living things. Some redwoods of the western United States tower more than 300 feet into the sky. Also in the United States, bristlecone pines up to 5,000 years old still live and flourish.

The world's oldest living tree is the bristlecone pine—WPN—114—growing at 10,750 feet above sea-level on the north-east face of Wheeler Peak (13,063 feet) in eastern Nevada, U.S.A. During studies in 1963 and 1964 it was found to be about 4,900 years old. It is estimated that the potential life-span of a bristlecone pine is nearly 5,500 years.

Conifers usually have a single, unbranched trunk. The leaves of conifers vary considerably in arrangement and in appearance. A fir tree has needle-like green leaves which densely clothe the branches. Pine trees have two kinds of leaves, needle-like, green foliage leaves and small, brown scale leaves. The green needles grow singly, in pairs, or in groups of up to five, depending on the species. Some conifers have scale-like green leaves which overlap each other and lie close to the stems.

Most conifers are evergreens and their leaves are well adapted to the cold conditions in which the majority of these trees live. Cold winter winds tend to draw water from the plants, but when the soil is frozen the plants cannot replace lost water so easily. Plants of cold regions therefore need fairly compact leaves, with a relatively small surface area through which they can lose water. This is just what the needle-shaped conifer leaves provide. In addition, the leaves have a thick, waxy coating *(cuticle)* and their pores, or *stomata,* are sunk below the surface. These two features discourage water loss even further. Some conifers go one stage further still and drop all their leaves in the autumn. The larches are examples of these deciduous conifers. The evergreen conifers do drop their leaves of course, but not all at once.

The stem, or trunk, of a conifer is much the same as that of flowering plants, except that conifers conduct water through dead cells called *tracheids.* Neighbouring tracheids are not joined together to form long tubes as xylem vessels are in flowering plant stems. There are holes



(pits) in the tracheid walls and water flows through these pits.

Conifers reproduce by means of sex cells produced in specialized structures called cones. In the Scots pine *(Pinus sylvestris)*, a very common example, male and female cones develop on the same tree. Male cones are yellow clusters of scales arranged spirally round a central stem. Each scale bears two pollen sacs on its underside. In early summer, clouds of pollen are blown by the wind to the young female cones, which look like pinkish buds at the tips of young shoots. Female cones consist of spirally arranged scales. The upper part of the scales bears the ovules. Although pollen reaches the female cone safely enough, fertilization does not take place in the Scots pine until the following year, and the seeds do not ripen until a year after that. The seeds are scattered by the wind as they fall from the open cone.

Connecticut, a small state on the north-east coast of the United States, is part of New England. It has many industries, but is also a major holiday area, with many beaches, lakes, woodlands and historic sites. Its people are among the

Location map of Connecticut.

most prosperous in America. Hartford, the state capital, Bridgeport and New Haven are the biggest cities. The population of Connecticut is 3,032,000.

Manufacturing has been important in Connecticut since the 1700's. Today some of its chief manufactures are transportation equipment, including aircraft engines, ships and submarines industrial machinery, office equipment, electrical goods, tools, chemicals, and food products.

Connecticut was colonized by settlers from Massachusetts in the 1600's. The colony's charter (1639) was one of the first written constitutions of a self-governing people. The people of the colony played an important part in the American Revolution. In 1788 Connecticut became the fifth state of the United States.

Conservation is the safeguarding and preservation of natural resources, so that they can continue to be used and enjoyed. In the past, most people believed that the world's resources could never be used up. Today, we know that this is not true. An important part of conservation is the prevention of waste – waste of forests, soil, wild-life, minerals and human lives. As important is the fight against *pollution* of our environment, in particular the

Young palm trees planted in the desert. Matting stops the wind from blowing away the sand in which they stand. Palm trees help to bind the earth together and make it fit for cultivation.

Local people remove rubbish and weed from a pond and so help to conserve the environment. Too much vegetation in water kills off the fishes and will eventually completely clog the pond.

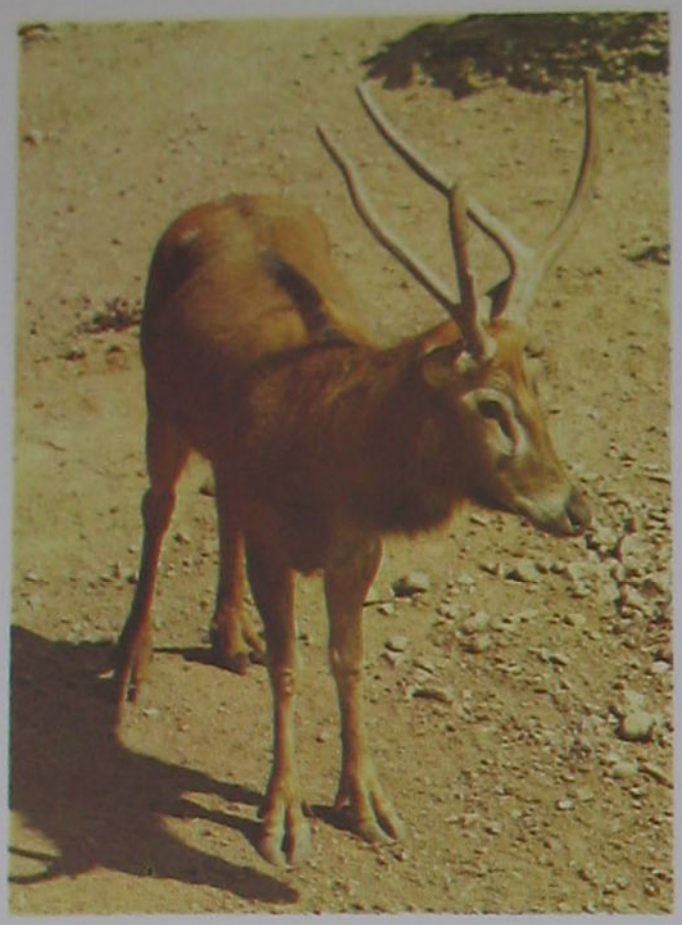
dirtying and poisoning of air and water. Conservation is also concerned with the reclaiming of land—by irrigating deserts, draining swamps or pushing back the sea.

Over the centuries Man has used his surroundings unwisely, acting as if the Earth's resources were limitless. In North America settlers cut down whole forests. In southern Europe, Africa and Asia overgrazing and fire destroyed extensive grasslands. And everywhere hunters killed animals for their furs, for ivory, and for other valuable products; and, as a result, many species of animals became extinct.

Today people are becoming more aware of *ecology*, the relationship of living things to one another and to their *environment* or surroundings. In almost all countries, governments and members of the public are taking part in schemes aimed at preventing unnecessary destruction and wastage of the world's riches.

Because most of our food comes from the land, the conservation of top-soil is important to everyone. This fertile layer of soil is only inches deep and can easily be washed or blown away, a process called *erosion*. It can also be robbed of nutrients by too much rain or by overcultivation. Farmers can protect their land by yearly *rotation* of crops—that is, growing different crops on the same land from year to year. In this way different elements of the soil are used each year and the soil has time to replace lost elements. Farmers can help enrich the soil by adding fertilizers. They can prevent erosion by ploughing along the contours of a hill rather than up and down. In this way water does not run off and take soil with it. By allowing part of their farms to remain *fallow* (be used only for grazing) each year farmers help the land to renew itself.

Trees and shrubs are also needed to preserve land because their roots bind



Many animals are in danger of becoming extinct, either because of man's ruthless hunting or because their environments have been destroyed. Left: The Père David deer originally came from China, but it is now extinct there. A herd does exist in the park of Woburn Abbey in England, where the deer were brought at the turn of the century. Opposite: The giant panda also comes from China where it has become a rarity. Today animals in danger are rigorously protected.

the soil and retain water. When all the trees in a region are cut, the soil can easily become loose and blow away. This happened in the south-west United States, causing the region to become a barren 'Dust Bowl'. In rainy regions a different danger can result from bare, ploughed soil. Instead of sinking gently into the soil, rainwater runs over the surface directly into rivers, which cannot handle the volume and flood.

To prevent flooding, many countries have built dams on rivers to hold the water back at a safe level. The water controlled in this way can be used for irrigation, for city water supplies or for producing cheap, clean hydroelectric power. When the dam forms a lake, people can use it for swimming or boating. Enormous flood-control schemes have been built on the Tennessee River in the United States and on the Nile in Egypt.

Forests provide timber, one of Man's most valuable resources, but they must be managed carefully. Only mature trees should be cut, leaving the young ones to grow bigger. Areas cleared of trees should be small so that neighbouring trees can reseed them. Fire spotters must be trained to catch fires while they are still small enough to handle.

To protect wild-life, many countries have passed laws restricting hunting and fishing. There are also some international agreements on hunting, such as those protecting seals in the Bering Sea. *Wild-life preserves*, areas where animals are protected within their natural environments, are becoming more common in regions where animal life is threatened. Tourists can pay visits to enjoy the scenery and photograph the animals. There are many such parks in North America and Africa. South Africa's Kruger National Park is the world's largest animal preserve.

Man and other creatures need clean air and water to live. In many rivers and streams, fish die because of chemicals and sewage heedlessly dumped in the water by Man. Scientists estimate that at the present rate of pollution the canals of Venice will be completely empty of life in a few years. Dirty air is chiefly a city problem. London's famous 'pea soup' fogs were cleared by laws forbidding the burning of soft fuels; but car exhaust fumes continue to pollute the air. Some large cities may have to ban cars from the city centre to wipe out *smog*.

Minerals that are taken from the Earth in immense quantities include petroleum, coal, natural gas, iron and copper. Once used up, these minerals can never be replaced. To conserve them, we must cut waste and *recycle* (put back into use) the metal in discarded products, such as empty cans. Conservation also includes searching for alternative fuels, such as the energy of the Sun.

Human resources can be conserved by such measures as medical projects aimed at cutting infant mortality and preventing epidemics, by slum clearance, and making education available to greater numbers of people. The United Nations, through UNESCO, the World Health Organization, and other organizations, is constantly working to prevent the wastage of human life.

Talking points

*Discuss your own environment and see if you can do anything to conserve or improve it. There may be a stream that needs clearing of rubbish, or there may be plastic or glass in the countryside that could harm wildlife and needs removing. Remember, it is *your* environment and *you* should help to preserve it.

*Find out if there is any pollution in your area. If there is, discuss the problem with your parents or teachers. Together you could write to the people responsible pointing out how they are damaging the environment.

Articles to read

Animal Kingdom; Birds; Dust Bowl; Ecology; Extinct Animals; Fishes; Forestry; National Parks; Whales; Zoos.

A dust-cart transports people's waste from their bins to a rubbish dump. Much of the metal, rags and paper can be *recycled* (salvaged and used again).

Constantine I (*c.* 288-337), known as Constantine the Great, was the first Christian Roman emperor, and founder of Constantinople. He became emperor of the western part of the empire after defeating his chief rival and joint-emperor, Maxentius, at the battle of Milvian Bridge in 312. Just before the battle Constantine claimed to have seen a vision of a fiery Christian cross with the words *In this sign conquer*. He immediately accepted the new Christian faith, and it became one of the tolerated religions of the empire.

In 323, Constantine defeated his eastern rival, Licinius, the emperor of the eastern part of the empire. In this way Constantine became master of the entire empire. In 325 he summoned the bishops of the Christian Church to a council at Nicaea. At this council the Nicene Creed was formulated which contained a summary of the official beliefs of members of the Christian Church.

Constellations For thousands of years men have looked at the stars and picked out recognizable shapes and patterns. Soon they built up stories about these groups of stars, or *constellations*.

The Chinese, Arabs, Babylonians, and Egyptians were among the first people to name the constellations and to use them as guides to sailors and travellers. The Ancient Greeks knew of 48 constellations, which they named after their heroes and gods. But it was the Roman astronomers who gave the constellations the Latin names by which we know them.

One of the most famous constellations is Ursa Major, the Great Bear, whose seven chief stars form the Plough. Two of the Plough stars are called the *Pointers* because they always point to Polaris, the Pole Star. This is the star, immediately above the Earth's North Pole, around which all the other stars seem to revolve.

Today astronomers recognize 88 constellations. The 23 constellations in the far south of the southern hemisphere were first named by 18th century astronomers.

Although the Earth moves around the Sun, it appears from Earth that the Sun moves in front of the background of stars. The twelve constellations through which it passes in this way are called the *signs of the Zodiac*. The twelve constellations of the Zodiac are Aries (the Ram), Taurus (the Bull), Gemini (the Twins), Cancer (the Crab), Leo (the Lion), Virgo (the Virgin), Libra (the Scales), Scorpio (the Scorpion), Sagittarius (the Archer), Capricorn (the Sea-goat), Aquarius (the Water-carrier), and Pisces (the Fishes).

Constellations of the Northern Hemisphere

Constellations of the Southern Hemisphere

Constitution Every country is governed according to its own rules. In most cases these are written down; this is the constitution. Britain is unusual in not having a written constitution. Some of the rules by which Britain is governed are Acts of Parliament; others are simply customs; these are called constitutional conventions. In Britain the rules can be changed by passing an ordinary law. A written constitution can only be changed by special laws. In the U.S.A., for example, amendments to the constitution have to be approved by two-thirds of both Houses and then be accepted by three-fourths of the States. (See Government; Parliament.)

Continents The seven great land masses of the Earth—Europe, Asia, North America, South America, Africa, Australia and Antarctica—are called *continents*.

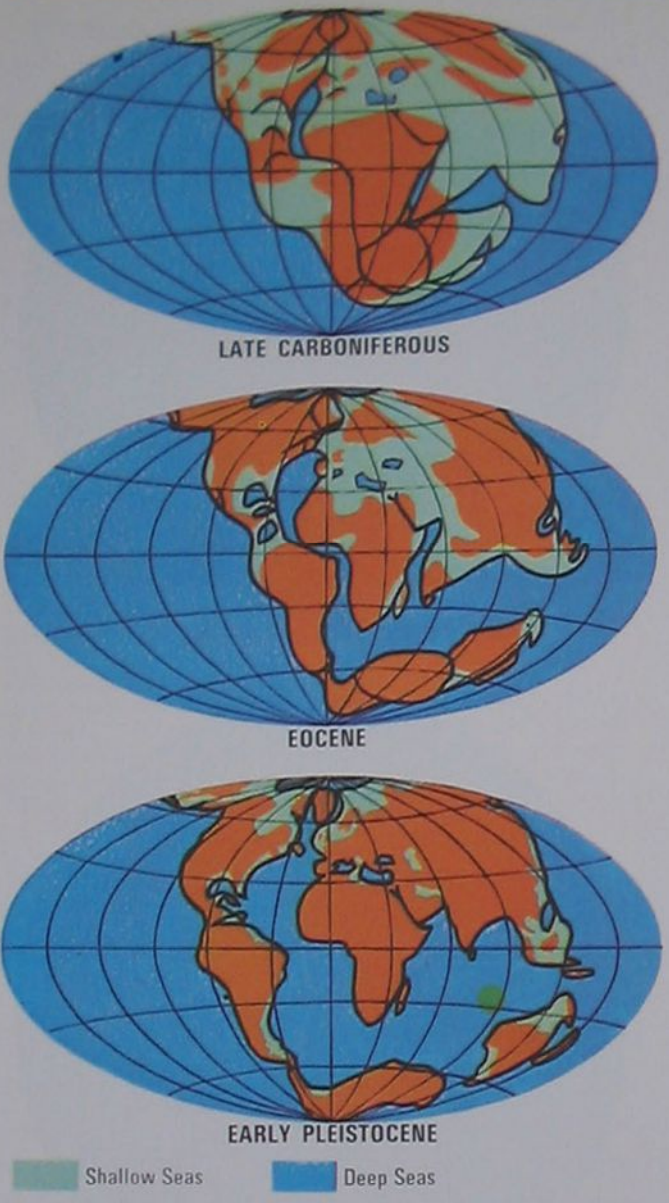
Each continent is basically a vast 'raft' of granite 'floating' in the denser basalt rock which lies beneath.

The coastline does not mark the true edge of a continent. The land slopes out beneath the sea, often for a considerable distance, forming the *continental shelf*. Over the shelf the depth of the sea increases only gradually, reaching approximately 600 feet at the edge. The sea bed then plunges dramatically.

The continental shelves are now being explored for valuable mineral and gas deposits.

As early as 1620 it was noticed that the continents of Africa and Europe on one side of the Atlantic and the Americas on the other would fit into one another like the pieces of a giant jigsaw puzzle. This led to the suggestion that perhaps they had once been connected and had since drifted apart.

In 1908 this idea of *continental drift* was revived to explain the formation and



Wegener's three maps illustrating continental drift. The latitude of the various continents is purely arbitrary.

The fold mountain belts of opposing continents match very well. The Caledonian (orange) and Hercynian (green) fronts approach each other in Europe and actually meet in America. The Alpine folding ranges (red) can be seen to have originally formed one huge system.

distribution of the great mountain ranges which appear to be exactly matched across the Atlantic. F. B. Taylor suggested that in Cretaceous times there were only two great land masses—*Laurasia* in the north and *Gondwanaland* in the south—which both drifted towards the Equator. As Laurasia drifted southwards, its leading edges were crumpled into mountain ranges, while its trailing side broke up to form the complex islands of northern Canada. Similarly, as Gondwanaland drifted northwards, it also split into several pieces—Antarctica, South America, Australia, India and Africa—and its leading edge was crumpled into mountain belts.

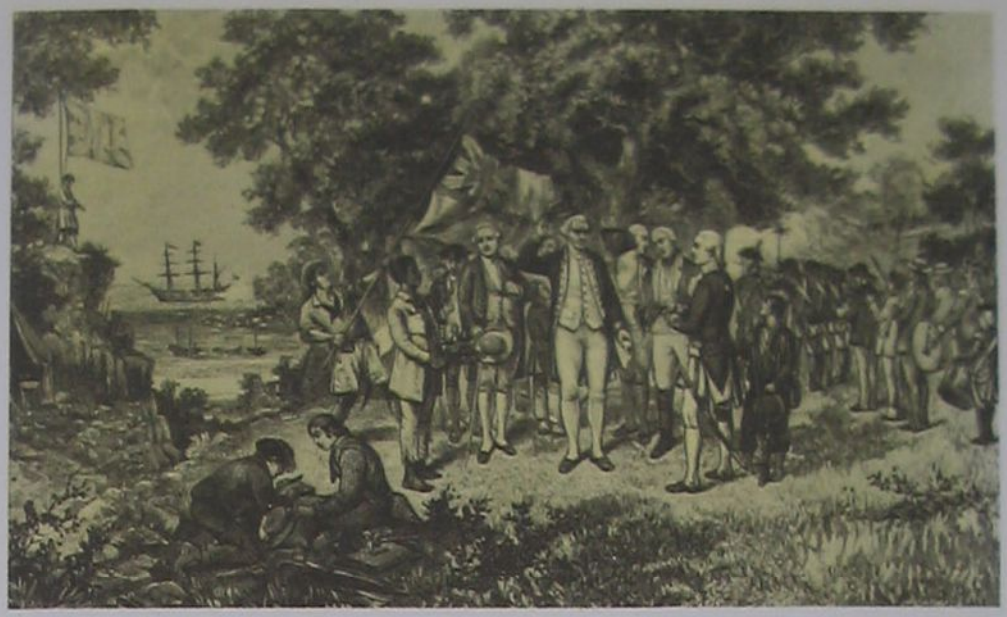
In 1910 Alfred Wegener, a German meteorologist, produced a similar theory which explained the great changes in climate. We know such changes were experienced by the various continents in past ages from the fact that coal, which is the fossilized remains of swampy *tropical* forests, is found in such places as Alaska and Antarctica. It is difficult to imagine these icy wastes once having a tropical climate unless they were much nearer the Equator at one time. Wegener suggested that there had originally been one great continent *(Pangaea)* which split in Cretaceous times to form Laurasia and Gondwanaland, separated by a wide sea *(Tethys)*.

Cook, James (1728-1779), was a British navigator. He explored the South Pacific Ocean and laid the foundations for British colonization of Australia and New Zealand.

In 1768, after a distinguished career in the Royal Navy, Cook was given command of a scientific expedition to Tahiti to study special movements of the planet Venus. Having accomplished this mission, Cook, in the *Endeavour*, went on to sail round New Zealand, charting both islands. He then surveyed the east coast of Australia, and returned to England in 1771.

On his second expedition, in 1772, Cook

Below: Portrait of Captain Cook. Right: Cook proclaiming New South Wales a British possession in 1770.



set out with the *Resolution* and *Adventure* to look for a southern continent. He plotted a number of Pacific islands, and revisited New Zealand. He also became the first man to cross the Antarctic Circle. When he returned to England in 1775, he had covered 60,000 miles in three years.

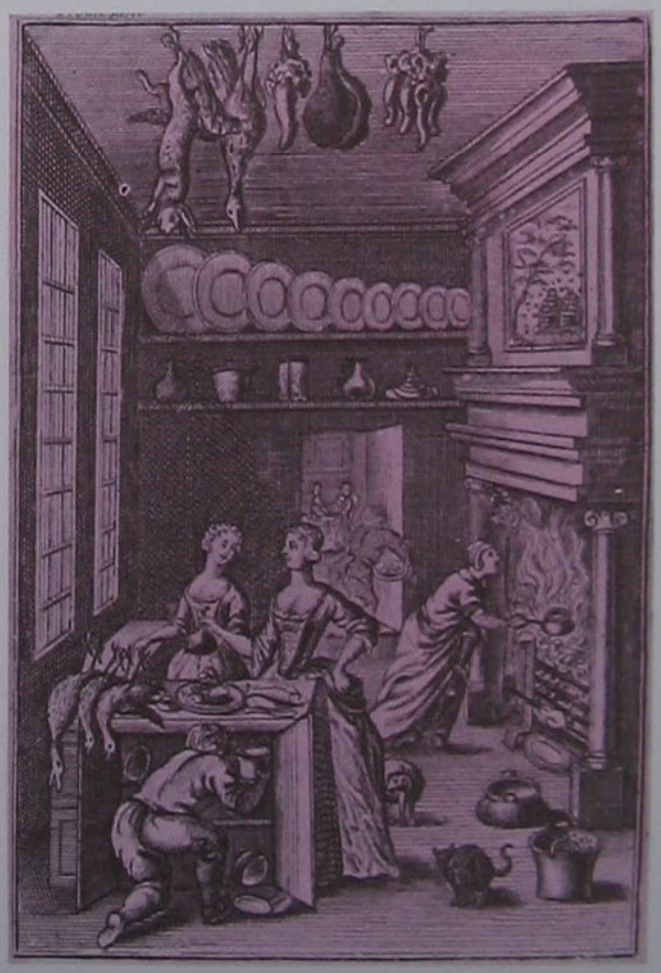
On his third voyage, in 1776, Cook took the *Resolution* and *Discovery* to look for a direct water route from the Pacific to Hudson Bay. He reached New Zealand in 1777, rediscovered the Sandwich Islands (now Hawaii), and reached the west coast of North America in 1778. He sailed northwards as far as the Bering Strait, but ice blocked further progress.

Cook returned to Hawaii in 1779. While trying to retrieve a stolen boat, he was clubbed to death by an islander.

Cook, Mt, is the highest peak in New Zealand. It rises to 12,349 feet in the Southern Alps in the South Island, and was named after the explorer James Cook by John L. Stokes in the mid-19th century. The mountain's name in Maori is *Aorangi*, meaning 'cloud-piercer'. It was first climbed in 1894 by Fyfe, Graham and Clark. Today it forms part of Mount Cook National Park.

Cooking Most of the foods we eat are cooked, because cooking makes them easier to digest and more enjoyable to taste. Good cooking is both a science and an art. It is a science because it requires much knowledge—for example, knowledge of the techniques of mixing and heating ingredients, of making bread rise and of thickening sauces. It is an art because a cook must have imagination

A 17th-century kitchen. Cooking was largely done over open fires, and the cook had several assistants to help feed the large household.



Few people now have time to prepare meals of many courses and the dishes themselves are far less elaborately served. Among the many modern items of kitchen equipment which help today's busy cook are tough but decorative dishes like this one, which can be taken straight from the cooker to the table.

and understanding to find out which foods go well together, and to achieve delicate blends of flavours by the use of spices, herbs and seasonings. Good cooks take pride in making the dishes they prepare look attractive.

There is no limit to the number of different dishes that can be prepared by combining various ingredients. Cooks can invent their own recipes, or can follow recipes given in cookery books. These explain the ingredients to use for each dish, the amounts needed and the methods of preparation.

Cooking methods have to be suited to the ingredients of the dish. Tougher cuts of meat usually require *stewing* (long cooking with plenty of liquid). Tender cuts can be cooked more quickly without liquid by *frying* (cooking over a high heat using fat or oil) or *grilling* (cooking directly under an open flame). Joints of meat are often *roasted* (cooked in an oven or on a spit over an open flame). Most breads, cakes, pastries and biscuits are *baked* in an oven.

No one knows how people first got the idea of cooking their food. But we know that prehistoric men roasted the animals they ate. By the time of the great ancient civilizations, most of today's basic cooking methods were already in use. The Romans paid great attention to food, and gave massive banquets with many courses of elaborate dishes.

For many centuries the main ways of cooking were boiling and roasting over an open fire. Meat was turned over the flames on a spit. Ovens were later built into fireplaces, but poorer people often took their dishes along to the baker to cook in his oven. Cast-iron stoves were used in Europe in the late 1400's, but cooking stoves became popular only in the 1800's.

Today's cooks have a wide range of kitchen aids: gas and electric cookers, refrigerators and freezers, and electric liquidizers and mixers. For ingredients, they can use all sorts of tinned and frozen products, as well as fresh food.

Talking points

*Cooking varies from one part of the world to another. For instance, the Indians cook a lot of curry while the French use a lot of garlic in their dishes. Discuss why this should be so.

*Imagine that somebody very important is coming to your house for a meal. Plan a well balanced meal that they would enjoy.

*Cooking makes our food taste better, but there are other important reasons why we cook many types of food. What do you think they are?

Articles to read

Bacteria; Diet; Digestion; Food; Food Preservation.

Cooper, James Fenimore (1789-1851), is usually thought of as the first important American novelist. He described the hardships and excitements of early America. His first successful book, set in the American War of Independence, was *The Spy*. His best known novels include *The Last of the Mohicans*, *The Pathfinder*, and *The Deerslayer*, which tell of a frontiersman and his Indian friends.

Cooper was brought up in Cooperstown, a village in New York State which was then a frontier settlement. His memories of the village, and the Indians who were in daily contact with the settlers, gave him the background for his novels.

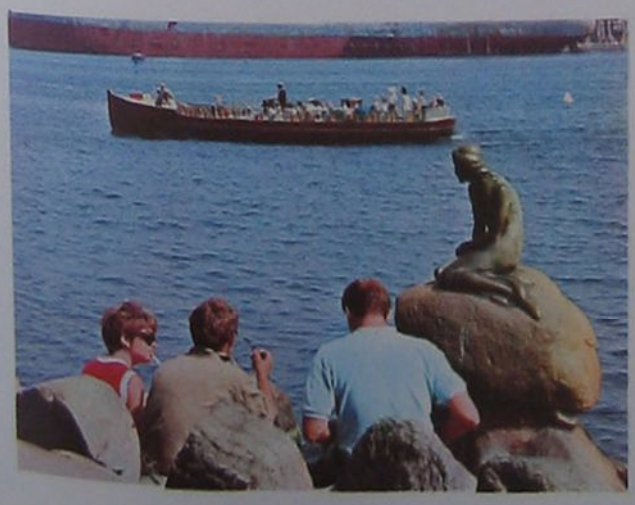
Copenhagen (pop. 1,460,000) is the capital and chief port of Denmark. It is situated on the east coast of Zealand Island, with a small portion on the adjacent island of Amager. The city was founded in the twelfth century and has become Denmark's chief commercial centre. It has a large trade in grain, wool, butter and metals. The city is famous for its porcelain ware. The free port of Copenhagen is one of the principal transit ports of northern Europe. The ancient Christiansborg Palace is the seat of government. Amalienborg Palace is now the royal residence. The university was founded in 1479.

Copernicus, Nicolaus (1473-1543), a Polish astronomer, was the founder of modern astronomy. Born in Prussia, he studied theology, astronomy, medicine and mathematics at the University of Cracow. In 1496, he went to Italy to read law. The next year he was made canon of Frauenburg, though it was some years before he went there, and in 1505 he became physician to his uncle, the bishop of Ermland.

Copernicus spent many years formulating a new theory of the universe. In his great work, *De Revolutionibus Orbium Coelestium*, published at the end of his life, he showed that the Earth and the other planets revolve round the Sun, and not the other way round.

Copper is one of the few metals which can be found in the pure state in the Earth's crust. Probably for this reason, it was one of the earliest metals known to man.

Below: The little mermaid at Copenhagen, Denmark, is a popular tourist attraction. Right: A Moroccan coppersmith fashions beautiful trays and other objects. Above right: The interior of a copper mill. Large bars of refined copper are produced from copper ore.



It is easy to see why copper has remained one of man's most useful metals over thousands of years. It has an attractive reddish-orange colour. It can be easily beaten into thin sheets and complicated shapes and drawn into wire. It does not rust or wear away quickly when exposed to the weather. Jewellery, ornaments, vases, and cooking vessels are some of the objects made from copper.

Copper is particularly useful for cooking vessels because it conducts heat well. It also conducts electricity well and most copper is in fact used in the form of wiring by the electrical industry.

Copper also forms valuable alloys – brass with zinc and bronze with tin. Both are harder than copper. With nickel copper forms the bright cupronickel alloys widely used for coinage.

Most copper is obtained from chalcopyrite, or copper pyrites.

Copra is the dried kernel of the coconut. This 'meat' of the coconut is white and edible. To manufacture copra, it is cut into strips and dried. This is done by leaving it in the sun, heating it in ovens or passing it through hot air. The copra is then pressed to extract the oil, which makes up almost 70 per cent of the product.

After the oil has been removed, the dry cake is used to feed livestock, or ground into fertilizer. The oil is a valuable commercial product, with many uses. It goes into foodstuffs such as margarine, and is also used for lubrication. It is the main ingredient in certain kinds of soaps, candles and cosmetics.

Most of the world's supply of more than 3 million tons of copra a year comes from the Philippines, Indonesia and India.

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Copyright lasts for varying periods, according to the country concerned and the type of work. In the United Kingdom, an author's copyright lasts for his lifetime and 50 years after his death. Many countries have signed special agreements which give copyright owners international protection.

Coral is a formation of limestone built up in the sea by millions of tiny animals called *coral polyps*. Each polyp is a jelly-like animal that builds a cup of limestone around itself. As in anemones, to which corals are related, the mouth is surrounded by tentacles carrying stinging cells and used to paralyse prey.

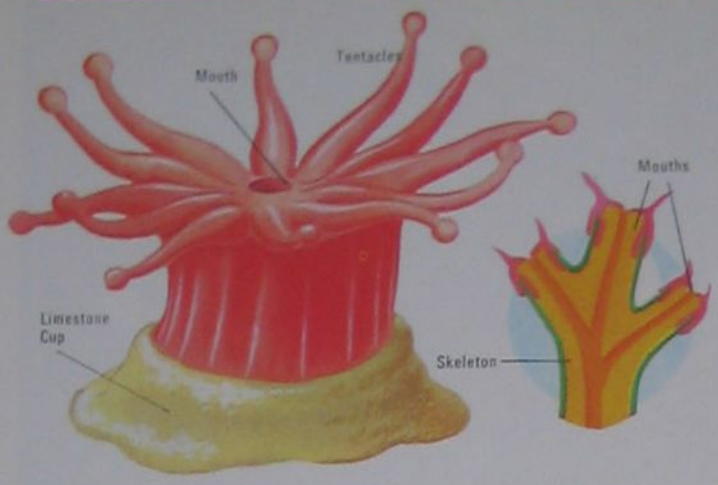
Most corals live in colonies. The limestone cups, or skeletons, of the many individual polyps in a colony form a branching formation of limestone in the sea. As the polyps reproduce, so the formations get larger.

Some formations can be delicate and lace-like. But others build into great *coral reefs* and *atolls*. Reef-building corals live only in the tropics, as they cannot survive in water with a temperature lower than 18° C (65° F). Other corals can be found in cooler waters. Many coral formations have beautiful colours. This is caused by the polyps themselves, and if the formation is removed from the water the polyps die and the colour fades.

Coral reefs form at depths of not more than 150 feet and grow until they break the surface.

The largest underground copper mine in the world is the El Teniente mine near Santiago, Chile, which has 200 miles of tunnels and produces 11 million tons of ore every year. Copper was first used about 10 thousand years ago to make ornaments in the ancient civilizations around the Tigris and Euphrates rivers in Mesopotamia.

Opposite: Dehusking coconuts – the first stage in the making of copra.



Above: The structure of a single coral animal (left) and the method of budding that produces new polyps.
Below: Two corals—Organ-Pipe Coral (left) and Brain Coral (right).

There are three kinds of coral reefs. *Fringing reefs* are found along a shore, extending only half a mile out to sea. *Barrier reefs* are situated offshore, separated from the land by a deep channel (as in the Great Barrier Reef along the east coast of Australia) or a lagoon, which may be many miles wide. Barrier reefs are mostly found around small islands in the ocean. *Coral atolls* are great ring-shaped reefs. Coral islands form when sediment and debris build up on a barrier reef or atoll.

Cork is a tough, spongy substance found in the bark of trees. Cork is waterproof, heat-resistant, and extremely lightweight. It gives the tree plenty of protection against the weather, and against harmful insects and fungi. The cork oak tree of the Mediterranean region produces copious quantities of cork, and is grown commercially for this reason. Cork is stripped from the bark of these trees once in every nine years, when a layer an inch or more thick may be obtained. Cork is used for shock-absorbers in machinery, to seal bottles, and to make floor tiles.

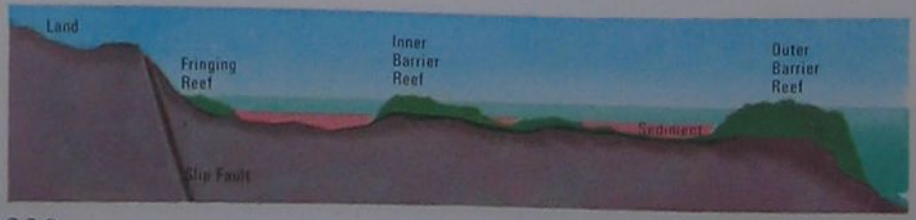
The first people known to have used cork were the ancient Romans who, in about 400 B.C. used it to make sandals and for fishing floats. It was first used to stopper bottles during the 1600's. The cork oak is one of the longest lived trees and can survive for up to 400 years.

Cornwall is a county in the extreme southwest of Britain. It includes the Scilly Isles, and its area is 1,357 square miles.

Cornwall is entirely surrounded by sea, except for its eastern boundary, which borders Devon. No point in the county is more than 60 miles from the sea. Inland, Cornwall is rugged and hilly, with huge outcrops of granite. The scenery along the coasts is magnificent, with luxuriant vegetation surrounding rocky coves and cliffs.

Cornwall's mild climate attracts thousands of tourists. It also makes it possible to grow and market early flowers and vegetables. In the 4th century B.C. Cornwall was exporting tin to France, and it was the world's major source of tin until the early 1800's. *Kaolin* (china clay) is still mined extensively. Truro is the administrative centre of the county; Penzance and Falmouth are the chief ports.

The ancient Cornish language, related to Welsh and Breton, was spoken in Cornwall until late in the 18th century. Many places names in the county are Cornish. Thus tre means village, as in Tregarn, 'the village of the caer (fort)', pen means headland as in Penzance, while lan means 'church' as in Landewednock.



A simplified section across the Great Barrier Reef of Australia shows how a faulted area has submerged and formed a suitable platform for coral growth. The barrier reef is in fact a complex series of smaller reefs.